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FAO — The Food and Agriculture Organization of the United Nations — grew out of a United Nations Conference held at Hot Springs, Virginia, U.S.A., in May 1943. The nations agreed to work together to secure a lasting peace through freedom from want. The Organization was formally founded at Quebec, Canada, in October 1945. It was located at Washington D.C. until 1951 when the Headquarters office was moved to Rome.

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Cover Photograph. *Village women of the Rif mountain area of Morocco returning from their work in the fields. On the outskirts of the village, vegetation is sparse; the holm oaks and cork oaks have been cut for fuelwood and animal fodder. The development of this area, with its harsh climate, must be based on all its potential resources, agricultural, pastoral, forest and touristic. A national project for integrated development of the western Rif region is being financed in part by the United Nations Special Fund for Economic Development, with FAO acting as executing agency on behalf of the fund.*

Courtesy, Belin

Unasylva

An International Review of Forestry and Forest Products

AID TO DEVELOPING COUNTRIES

SPEAKING to the FAO Headquarters staff in May, Prince Philip, Duke of Edinburgh, recalled the League of Nations meeting in 1935 which first formally recognized the objectives from which FAO subsequently derived. He quoted the telegram which the small band of sponsors of the resolution sent to Lord Boyd Orr — later to become FAO's first Director-General — and which paraphrased an earlier famous saying: "Brother Orr, we have this day lighted such a candle by God's grace in Geneva as we trust shall never be put out."

Prince Philip went on to say that today most thinking people realize, if only vaguely, that a great fraction of the world's population is both underfed and badly fed. Few, however, really appreciate the grim facts and understand how desperately close is the race between the growth of population and the provision of adequate food resources.

"It is relatively easy to assemble and marshal impressive facts and figures to demonstrate the lopsided world food situation," he said, "but it is quite another matter to distil the underlying causes of this depressing and dangerous situation. Nevertheless, it is essential to establish the causes if the cure is to be really effective. Hunger is obviously due to lack of food but this lack of food may be due to any number of reasons, some purely technical and some very human.

"Technical know-how can achieve wonders but only if it is tactfully and thoughtfully integrated with the prevailing local conditions. Change of any kind cannot be entirely painless but at least care should be taken to prevent it causing disruption or disintegration. This means that the expert must combine a sound technical knowledge with a lively and practical understanding of human nature, if he is to ease the oppression of stagnant tradition. It is a fundamental truth that, while people of all races and cultures can agree about the practical and technical things in life, they most emphatically do not agree about customs and prejudices."

Prince Philip was speaking of the FAO Freedom from Hunger Campaign and the chance it offered to people of good will all over the world to convert their concern for their less fortunate fellows into a well directed action. His words above, however, are equally pertinent to the activities which are now growing under the United Nations Special Fund for Economic Development.

This new avenue for technical assistance was created in 1958 and operations began in January 1959. During its first year and a half, the United Nations Special Fund has granted nearly $60 million for projects in developing countries. FAO has been named as executing agency for a large proportion of these projects — at the moment 25 projects which are in operation and 45 projects which have been approved and await the start of operations. Many more projects in FAO's fields have been submitted by governments for consideration at future sessions of the Governing Council of the Special Fund.

FAO's Forestry and Forest Products Division has now direct responsibility for 9 approved projects and has a high interest in 20 other projects operated by other Divisions. These projects may be broadly divided into four categories. The first is preinvestment surveys, at present those arising out of FAO's Mediterranean Development Project — in the Antalya region of Turkey, the western Rif in Morocco, the western Peloponnesus in Greece, and in central Tunisia. The second category relates to the direct development of forest resources and industries, with projects in Chile, Honduras and Mexico. The third embraces land-use and settlement surveys — in Bolivia, Brazil, Ecuador, Ethiopia, Peru, the Sudan and Venezuela. The final category embodies education, training and research and already includes the creation of new institutions in Argentina, Brazil, Pakistan and the Sudan.

All this, it is hoped, is only a beginning. It means an accelerated shift in emphasis in the nature of the work of FAO, although there will be no abandonment of the basic services for world forestry development built up under the Organization's so-called Regular Program.

FIGURE 1. – *Striplings (left) and stumps of Para-para* (Jacaranda copaia) *from transplants about nine months old. The stumps give better results if dry weather follows planting; they are also easier to handle.*

FIGURE 2. – *Rapid growth by* Eucalyptus citriodora *fifteen months old after planting at 2.5 × 2.5 m. on a clear-felled and burnt area.*

Amazon Forests

Possible Methods of Regeneration and Improvement

G. J. W. Pitt
Technical Assistance Officer, FAO [1]

The principal object of management in the Amazon forests may be regarded as being to replace a forest composed of trees of all ages and of a large number of species, many of which are of little or no known use and in which the more useful species are usually the rarer ones, with a forest composed of a large number of individuals of a few useful and very useful species and of about the same age.

The vast area of the Amazon jungle, some 3.5 million square kilometers, gives many people a false sense of security on account of the apparently limitless supplies of timber. But the distances over which first-class commercial timbers have to be transported from stump to sawmill are already rapidly increasing, and the need therefore arises for improvement of those forests which are closer at hand.

Two of the main obstacles to the development of forest management in the Amazon are the lack of silvicultural information about many of even the better known species, and about the properties and possible uses of the lesser known ones. It was to assist in the former that a silvicultural section was included in 1955 in the FAO Forestry Mission to the Amazon.[2]

To carry out the task of assisting in the introduction of appropriate silvicultural methods, various preliminary investigations have been necessary. For such a vast area as the Amazon it is not practicable to investigate all the possibilities. Work therefore has been confined to a few special areas, namely, on the Curuá Una river 105 kilometers from Santarém; near Santarém; and near Macapá.

In the discussions later on in this paper the various generalizations will probably apply to most of the region though their possible limitation must be kept in mind. A full report on the first five years' work done is to be issued shortly by FAO.

Climate

There is a definite dry season in the second half of the year varying from about three to six months according to the locality. The mean annual rainfall may vary from 850 millimeters (C.B.A., Santarém) to 2,750 millimeters (Belém). Mean maximum monthly temperatures vary from 24°C. to 35°C., and the minimum from 19°C. to 25°C. Nights are usually cool, especially in the forest.

The level of the rivers can vary considerably. At Belém the tidal range is about 2 meters; at Santarém dry and wet season levels vary by about 3 to 4 meters, and at Manáus it once reached 16 meters. These changes would naturally affect work on the "varzeas," the periodic or seasonal swamp forests.

Principal forest types

1. *Swamp*
   (*a*) Varzea – seasonal or tidal
   (*b*) Igapó – permanent
2. *Terra firma*
   (*a*) Sandy soils – generally on quaternary deposits – flanco
   (*b*) Clay soils
      (*i*) "Planalto" – tertiary
      (*ii*) Undulating – may be a more denuded tertiary formation, or over old rocks, usually of the Brazilian shield.

Varzea forests, especially in the lower reaches, provide much of the timber today, though exploitation is confined almost entirely to floaters.

Igapó forests are poorer and provide little commercial timber.

Sandy soils carry forest generally low in volume and with few desirables; in places they carry only fairly low savanna.

Planalto clays can carry the highest volume (up to over 300 cubic meters per hectare of trees over 25 centimeters d.b.h.) and are rich in species; usually there are very few economic species, such as *Cedrela*, on a single hectare, though there may be several desirables.

It is only on the terra firma soils that exploitation by mechanical means is possible over most of the year, and the following notes refer only to these soils, and in particular to the planalto area by the Rio Curuá Una.

Possible degrees of exploitation

Creaming. The density or stocking of the "economics" is so low, e.g., 10 *Cedrela* per square kilometer, that the forest is virtually unaffected, except for occasional gaps and extraction tracks. Hand labor, with its limited range of about half a kilometer, is usual

[1] Mr. G. J. W. Pitt now teaches in the Department of Forestry, Oxford University.

[2] See *Unasylva*, Volume 12, Number 4.

FIGURE 3. – *Parapara* (Jacaranda copaia) *2 1/4 years old raised from small (20 cm.) striplings planted at 2.5 × 2.5 m. The canopy is already closed.*

for moving the logs from stump to stream or river; lorries are sometimes used, and occasionally even tractors for the first stage.

Heavy selective. In the Curuá, where the FAO team is logging, the planalto forest has some 120 different species over 25 centimeters d.b.h. with about 35 to 45 species on any one hectare. Of these some 30 to 35 percent are desirables, and represent about 40 percent of the stems or 30 percent of the standing volume. Sound trees of all the desirables are being felled and taken to the sawmill training center at Santarém, or used locally for camp buildings.

Intense. This implies more or less clear felling for pulp, with the best logs going to sawmills and/or plywood or veneer mills, and suitable second quality logs going to sleepers. On the planalto area referred to above, a 100 percent inventory over 13 hectares has shown a standing total volume of all trees over 25 centimeters d.b.h. of about 250 cubic meters per hectare (190–315). Recently a 100 percent inventory of trees over 45 centimeters d.b.h., but excluding the badly fluted trees, was carried out over a block of 100 hectares by Glerum and Smit (*11*).[3] The result shows an irregular stocking in the compartment over rather short distances. In this block, six species (five economic and one potentially so) gave 60 percent of the total volume – i.e., some 90 cubic meters per hectare, a very high figure for a tropical forest.

[3] The italicized figures in parentheses refer to literature cited at the end of the article.

SILVICULTURE

The value of pure silvicultural research is not to be disputed, particularly in such undeveloped forests as occur throughout the Amazon. However, in view of the terms of reference of the assignment, silvicultural work had to bear some relation to the possible degree of exploitation and utilization. Economic considerations therefore imposed considerable limitations. Valuable work, however, could be done now to improve the forests for exploitation at some future date — "refining," *vide* Dawkins (*5*) — but this is an aspect of management which is usually not considered, especially in tropical forests, owing to budget limitations. There is scope for considerable development in the intensity of the utilization of the planalto forests; until this takes place, the silviculturist can do little beyond showing how the forests can be improved both before, and after, exploitation.

Possible methods

Much has been written about tropical silviculture, and the methods which are most likely to be suitable to Amazon conditions are:

1. *Natural regeneration*
   (*a*) inducing *natural seedling regeneration* of desirables prior to exploitation, or encouraging regeneration normally under some degree of shelterwood;
   (*b*) *natural regrowth* of seedlings, coppice and perhaps suckers, following intensive exploitation.
2. *Artificial regeneration*
   (*a*) enrichment planting;
   (*b*) plantations.

Natural seedling regeneration. This would entail some degree of canopy opening by creeper cutting, killing some trees and cutting back the undergrowth of undesirable species, followed later by periodic killing of further undesirable trees and recutting the undergrowth.

Natural regrowth. Unless plantations are envisaged, natural regrowth would be encouraged to follow intensive exploitation. The initial seedling regrowth is likely to consist mainly of softer-wood, light-loving species and will result initially in a forest of a rather different composition. During the first few years it may be advisable to cut back the regrowth of the less useful species two or three times. Some management aim may perhaps dictate favoring only those soft-wooded species more useful for pulp, or encouraging useful harder timber species as well.

A heavy selective felling (eight trees per hectare) was carried out early in 1959. Some 18 months later, in most of the more open areas there was already enough regeneration of several desirables to make it possible

to decide in the first cleaning whether to aim at a final crop composed mostly of the softer-wooded species, or of the harder timber species such as *Goupia*.

Enrichment planting. This could be on a relatively small area, say one to two percent of a creamed area. Only valuable species, tolerant to shade, should be used. Such planting could be adopted in those parts of areas where natural regeneration has not been as successful as required. Similarly it might be suitable for accessible areas near centers of population where the present stocking of desirables does not justify exploitation.

Plantations. For these it would be necessary to clear fell an area and then burn it at the end of the dry season. Parts of easily accessible forest already creamed or with only a few desirables could be replaced by this method, particularly if they are near large centers of population. If plantations were undertaken it would be most important to have a variety of species and to avoid large pure stands.

There is no question of " taungya " at present as there is no land shortage. If intensive exploitation were to start on a large scale, then there would be definite possibilities for providing food for the laborers and for growing trees at the same time.

Work in hand

All the above methods have been demonstrated by the writer, often on two or three different sites.

No intensive exploitation is being carried out at present; therefore small areas (two to six hectares) have been clear felled and burned, after removal of the larger economic species. These have been used for camp building or sent to the FAO sawmill training center nearby.

Natural regeneration

Natural seedling regeneration. Plots have been laid down in three localities with two or three degrees of canopy opening; the size varies from one to four hectares, plus a surround. Weed trees have been poisoned with contact arboricides; various concentrations and mixtures have been tried; the most satisfactory seems to be a one to two mixture of 2,4-D to 2,4,5-T (both 80 percent acid equivalent) at three to five percent in diesel oil, depending on the species and size of the trees to be killed. A few resistant species are frilled before spraying. The degree of opening was controlled by the number and size classes of tree poisoned, and later checked by girth measurements for basal areas (only trees over 25 centimeters d.b.h. were girthed). Recently a prism has been used for measuring basal areas. The original basal areas varied from 18 to 22 square meters per hectare and were reduced to about 11 square meters for a heavy opening and to about 15 square meters for a light opening. In a heavy opening, besides some large undesirables, some understory trees were also poisoned and the undergrowth of all undesirables slashed back.

Good regeneration of several desirables has been obtained in some plots two to three years after treatment. In one plot it has been considered advisable to cut back the weed regrowth after two years, and to thin out the useful regeneration to intervals of about 1.5 meters. A recent " milliacre " survey showed 98 percent of the quadrats (2 meters square) stocked with generally more than one seedling of the three main species, or occasionally with one or two of 11 other desirables.

Plots have been laid down to encourage regeneration of *Cedrela*, probably the most important species of the Amazon. There are three degrees of canopy opening, each with three ground treatments. A good seed year is expected.

FIGURE 4. – *Cupiuba* (Goupia glabra) *15-months-old raised from 40 cm. striplings planted at 2.5 × 2.5 m. (1,600 p. ha.). Note absence of weeds following an intense burn of clear-felled forest. Compare with Figure 5.*

FIGURE 5. – *Very successful natural regeneration of Cupiuba* (Goupia glabra) *2 1/2 years old, following a light burn of clear-felled forest. After two cleanings and one thinning the stocking is now 1,200 Cupiuba and 750 other desirables.*

Gregarious patches of seedlings of *Clarisia* and *Hymenolobium* have been encountered. As these trees are rare in the forest, these patches are being observed carefully; over some the canopy is being opened and the seedlings are being thinned out.

Natural regrowth. One of the problems is to recognize the seedlings. Seeds of desirables are being collected as opportunity offers and plants raised in the nursery. Later, the plants are put out into arboreta on the main soil types to obtain more silvicultural information.

Natural regrowth is being observed in the surrounds of plots clear felled for trial plantations. In the area which was first felled and was lightly burned in December 1957, good regeneration of *Goupia*, mainly from seed, has been obtained: 62 percent of the 2-meter quadrats were stocked by August 1958, and 49 were still stocked by June 1960 (average height of tallest in each plot was 2.5 meters). Weed growth had to be cut back in April 1959 and a 1.5 meter stick thinning was carried out by uprooting the surplus seedlings; seedlings of several more desirables have also appeared; some are in quadrats already stocked with *Goupia*, and some in 30 percent more of the quadrats, thus giving a total stocking of 79 percent with various desirables on about twice the minimum (40 percent) considered adequate. The plot can be regarded as fully stocked — there are very few gaps of over 10 or 15 meters — though more slashing back of weeds will be necessary for a year or two.

Where the logging unit has been operating, light burns are now being carried out where there is a dense mass of branches. These should result in good regeneration of *Goupia* and a few other desirables. A fierce burn is to be avoided, as in such patches the soil will still be comparatively bare, even after two wet seasons. However, if the burn is fierce and no natural regeneration appears, the patches can be safely planted up the next wet season with quick-growing species. These patches should not need a cleaning until the natural regeneration in the surrounding areas is being cleaned; it will thus not be necessary to look separately for these planted patches.

Artificial regeneration

Enrichment planting. Various spacings and degrees of opening are being tried. Even with shade-tolerant species, growth is usually slower than when these species are planted in the open. The main scope for enrichment planting lies in improving the composition of young secondary growth. It is also indicated in areas of fairly intense exploitation where the natural regeneration of desirables has not been adequate. It is clear, however, that in virgin high forest, poor in desirables, little improvement can be made except by a heavy, and therefore expensive, opening of the canopy and by using that rather rare phenomenon, quick-growing shade-tolerant species.

Both contact arboricides and girdling are being used to kill weed trees along the enrichment lines. Direct sowing of *Carapa* shows some promise and so do transplants of *Carapa*, *Clarisia*, *Vochysia*, *Hymenolobium*, and *Virola* after one year. Spraying with 2,4-D is being tried to keep down the weed regrowth along some of the lines.

Plantations. Practically all aspects of this work are being demonstrated. In the nurseries, besides the local soil, seedbeds been have made of "terra preta" (black sandy more fertile soil of uncertain origin and a little less acid, *p*H 5.6 as against 4.4), sawdust and river sand. Transplants are being raised in beds, boxes, galvanized iron tubes and earth pots (*torrão paulista*); plants from the

beds are put out as naked rooted, ball rooted, striplings and stumps. Only one or two methods are tried for any one species in one area. Everything is first tried out as naked rooted transplants. The only uniform procedure is the spacing, 2.5 × 2.5 meters, giving 1,600 plants per hectare. Work on various spacings can follow when the best technique has been established for each species.

Fertilizer trials with phosphorus are also in hand. On a poor degraded campos clay soil, nothing has succeeded without phosphorus, and even then the initial response with phosphorus was not maintained in the second and third years, except with some eucalypts. Cover crops (*Crotalaria*) are being sown to help check weed growth and improve soil fertility. Pruning and thinning will come later.

There has been considerable interest in the possibilities of intensive exploitation for pulp. The technical and economic aspects of this subject are outside the scope of this paper. However, if such exploitation starts and silvicultural methods can be introduced to give a forest with fewer species of more uniform properties, then a great step forward will have been made. To this end work is in hand on introducing pines, as these would also improve the furnish very considerably. The best pine is likely to be *P. caribaea*; difficulty was experienced in the first year in obtaining adequate mycorrhiza; and postal delays over seed cost us another year. Several trial plots with well inoculated plants were, however, put out early in 1959; results are promising.

P. khasya has not succeeded and postal delays twice resulted in *P. merkusii* losing its viability; we were more fortunate with the third lot and good plants were put out in 1960. Some 40 local species and 30 exotics including eucalypts are also on trial.

The main pest is *saúva*, the leaf-cutting or parasol ant; in general, indigenous species seem less delectable, but they too have been attacked. The ant seems more frequent on sandy soils and appears to be more abundant where there is poor or young secondary growth following clearings for cultivation.

Other operations

Pre-exploitation. These consist of creeper cutting, freeing young advance growth and freeing and thinning occasional patches of desirable gregarious seedlings. When more information is available as to the density of canopy required to encourage good regeneration of one or more desirables, the poisoning of weed trees will be undertaken.

Postexploitation. These consist of further freeing of advance growth, cutting back damaged young desirables and cutting young weed trees which, when larger, are resistant to arboricides. Exploitation, even when fairly intense, leaves some large patches often untouched. In these patches some weed trees are being killed to favor any young desirables. When these are absent, enrichment planting is indicated, provided suitable species have been found; in this case, poisoning of weed trees is necessary to open the canopy over the lines. Reference has already been made to the burning of branchwood in heavily felled patches.

Research

When introducing silvicultural methods to a virgin forest area it is impossible to go straight ahead with only field-scale operations. A tremendous amount of information about the composition of the forest has to

Figure 6. – *Part of the Curuá Nursery.* Terminalia superba *on left,* Gmelina arborea *between men. In six months time the former will be put out as stumps or striplings, depending on their size, and the latter will go out as stumps.*

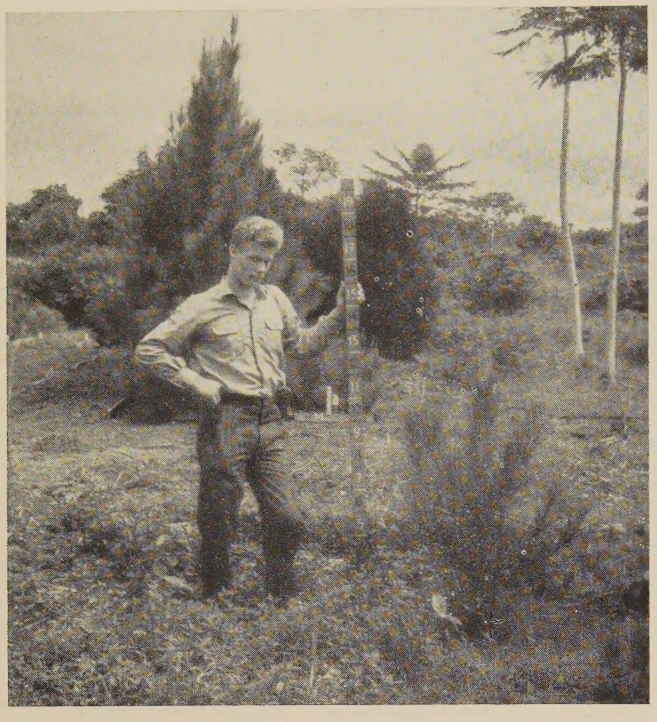

FIGURE 7. – Pinus caribaea. *15 months old on young (5 years) secondary forest soil, Macapá nursery. Note the 3 1/4 year old pine plants beyond and Parapara* (Jacaranda copaia) *on right, three years old.*

be found out, and about the silvics and silvicultural requirements, not only of the desirables, but also of the weed trees. This is quite apart from deciding which species are desirables and which are weeds.

A line usually has to be drawn between experimental work and research work. Where that line lies is a matter of opinion. Since there is so far no forestry section developed at the National Research Institute for Amazonia (INPA) at Manáus, plots of a more purely research nature have been established along with our demonstration and experimental plots.

Observations or measurements are being made on:

1. inducing natural regeneration by canopy opening and, in the case of cedar, by ground preparation;
2. resistance of all larger species to different concentrations of arboricides and to girdling;
3. amount of slashing back of weed growth needed to favor established or induced regeneration;
4. suitability of various species for enrichment planting;
5. various methods of raising transplants;
6. various methods of establishing plantations;
7. effect of using phosphorus fertilizers;
8. rates of growth of indigenous and exotic species in plantations on various soil types;
9. rates of diameter growth in virgin and in partly opened forest.

During 1960 some work was started by INPA near Manáus and an agronomist came three times to the Curuá for some training.

The pedologist with the FAO/UNESCO mission has visited all the silvicultural centers, studied soil profiles and had samples analyzed. The main features have been the very low fertility values as shown by the amount of elements present, and the high acidity (*p*H 3.9 to 4.9). This high acidity is probably a limiting factor in the introduction of some exotics and may explain why such species as teak have failed in most trials. Much work could be done in tropical forests on the *p*H requirements of the better known species and thus avoid many of the failures encountered when introducing exotics. The difficulties with mahogany in the nursery may also be due to acidity; where it was seen growing naturally by the writer on soils of much older geological origin, the *p*H was much higher – about 6.

Space does not permit to discuss in this article the various methods used in sampling the stocking and regeneration. These are being dealt with in the report which is being prepared for the Brazilian Government.

CONCLUSIONS

In these early stages, management must be extensive rather than intensive; stress should be more on natural regeneration than artificial, at least until intensive exploitation for special purposes starts. The principle should be: " Follow Nature; perhaps guide her, but do NOT dictate to her. " The introduction of exotics should be considered, especially if there is any question of future exploitation for pulp.

From the point of view of natural regeneration it is better to have an area with a relatively high volume of a second-class desirable, which it is fairly easy to regenerate and encourage, e.g., *Goupia*, than to aim at a first-class desirable which can be established only with difficulty, e.g., *Cedrela*.

It is far too soon to weigh the relative values of natural regeneration against artificial regeneration. Much more muddy water must flow down the Amazon before any reputable forester should give his considered opinions on this nice point. Fortunately, the Brazilian Government has asked for technical assistance to continue in the Amazon at least to December 1962.

COST OF OPERATIONS

The figures given below are what it is thought the operations should cost on a field scale with experienced labor. In many cases the work has so far been on a small scale, often with untrained labor.

Notes

1. Felling the largest trees a year or so ahead, and the medium-sized trees six months or so ahead of the small trees and undergrowth may result in a better burn and so avoid the need for collecting and reburning large branches and stems.
2. Planting costs on a large scale will vary considerably according to the type of nursery plants; naked roots transplants, striplings or stumps will cost less to plant than transplants from containers such as pots or boxes.

Cost of operations

Operation	Man days per ha.	Man days per km.
Linear regeneration surveys		3-4
Inventories	0.5-2.5	
Natural regeneration		
Pre-exploitation		
Creeper cutting and freeing advance growth	2	
Underbrushing (selective)	1-8	
Girdling	1-4	
Poisoning (light opening)	1	
Poisoning (heavy opening)	2	
Postexploitation – after clear felling and burning		
First cleaning (at 18 months)	18	
Second cleaning and thinning (at 2-2½ years)	25-30	
Postexploitation – after heavy selection felling		
Freeing advance growth	10-12	
Poisoning	1	
Enrichment		
Line cutting		1
Widening		4
Poisoning		1
Pitting		1
Planting		1-1.5
Cleaning		1
Plantations		
Underbrushing (try to avoid)	5	
Clear felling	20	
Clear felling (staggered) (Note 1)	25	
Felling desirables	6-8	
Clear felling remainder	12-14	
Collecting and reburning large branches and stems (Note 1)	20-30	
Pitting	2	
Planting (Note 2)	4-6	
Sowing cover crops	1	
Cleaning	5-6	

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Biological Control of Forest Insects

Recent Work and Future Aspects

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At the present time there is a considerable risk that a short general paper on biological control with particular reference to forest insects may merely be a repetition of previous work, since the concept of, and the approach to, this field of insect control have already been discussed twice during the past year by the very competent forest biologists Dr. M. L. Prebble and Dr. R. E. Balch of the Canadian Department of Forestry (*1*, *2*).[1] And it is only a year since two other authoritative publications, by Dr. F. J. Simmonds, Director of the Commonwealth Institute of Biological Control (*3*), and by Prof. G. C. Varley, of Oxford University (*4*), have outlined the past work and future trends of biological control in general, and of the control of agricultural pests in particular. Moreover, the present author has firsthand experience of only some of the problems concerning the biological control of European forest insects introduced into North America, problems which have already been dealt with in the two Canadian publications mentioned above.

There is, however, a certain difference in approach in that these two publications attempt primarily to show what is happening in Canada with regard to the natural enemies imported from Europe during the course of biological control work. This paper, on the other hand, deals primarily with the aspect of the investigations involved in the selection and provision of useful biological control agents for importation to other areas. Such studies involve a careful ecological investigation of the pest in question in its native habitat, in order to gain some idea of the biotic factors operating against the pest in its normal environment. Those biotic agents which would appear to be most suitable for its control in the area of introduction are then selected, collected and bred for shipment. The scope of the present paper will therefore be mainly restricted to the problem of the improvement of the present methods of introduction of biological control agents.

On the subject of possible improvements in biological control a difference in present opinions is immediately apparent. Dr. Balch (*2*) states, for example, "that ecological studies in the countries of origin [of the pest] are necessary but unlikely to be conclusive." He emphasizes that in the biological fight against an introduced forest insect, "all available primary parasites, predators, and diseases should be imported, but priority should be given to those found in ecologically similar regions where the pest is indigenous and under adequate natural control."

If one takes into account the close similarity existing between the forest types of boreal Eurasia and North America, the latter part of Dr. Balch's contention must undoubtedly be strongly supported. Some general methods of assessing the ecological correspondence between areas of collection of biological control agents and those where they are to be released have already been outlined elsewhere by the author (*5*).

However, it is doubtful whether this represents the only facet in which preliminary investigations may assist in biological control problems relating to the species and numbers of natural enemies selected, the selection of areas in which they are collected, the order of their introduction, etc. On the contrary, it is thought that it is this marked ecological similarity between the main forest types of the Old and the New World — a similarity due to the long period of common evolutionary history prior to the late Tertiary Period — which may provide the possibility, by means of detailed comparative studies, of a closer approach to more selective methods of biological control, rather than the general procedure of "trial and error" which has prevailed in the past. As Varley (*4*) has pointed out, this problem is all the more important since biological control measures once successfully achieved are often irrevocable.

One of the problems in which this question has now become acute is that of the European pine sawfly, *Neodiprion sertifer*, in North America. This Eurasian forest insect was accidentally established in eastern North America some 40 years ago. There it damages not only Scots pine plantations utilized commercially for Christmas trees but also attacks several native American pines (*6*). A number of parasite species have been successfully introduced from Europe against this pest — partly in connection with another biological control program concerning the related European spruce sawfly (*Gilpinia hercyniae*) (*2*). These parasites have been released in southern Ontario and in the adjacent United States. However, only one of these parasite species became abundant while three others, though established, remained quite unimportant, and seven species apparently failed to become established. On the other hand, a surprisingly large number of native American parasites adapted themselves spontaneously to the new host, exerting an average parasitism of some 20 percent (*6*).

[1] The italicized figures in parentheses refer to literature cited at the end of the article.

It seems reasonable to suppose that some of these results could have been predicted had a comparative analysis of the pest and its complex of natural enemies, both in Europe and in North America, preceded the rather disappointing introductions of parasites from Europe which entailed the collection and shipment of nearly 30 million pine sawfly cocoons. *Neodiprion sertifer* is the only member of this genus in Eurasia. All other species of *Neodiprion*, some 25 to 30, have a purely Nearctic, i.e., American, distribution. This suggests the possibility that *N. sertifer* itself might not be of truly Palaearctic origin, but rather an old Nearctic immigrant which reached eastern Asia before or during the Ice Age and afterwards spread as far as western Europe — compare also Ross (*7*). This species has only a single generation annually and overwinters in the egg stage as opposed to the other pine sawflies of Europe which are generally two-brooded (i.e., bivoltine) and pass the winter in the cocoon stage. As a result, European parasites apparently had certain difficulties in adapting themselves to the life cycle of such an " outsider " host. Indeed, only three species of Ichneumonids (*Lophyroplectus luteator*, *Exenterus abruptorius* and *Lamachus eques*) have succeeded in synchronizing their life histories with that of *N. sertifer* in Europe, and even some individuals of these parasites still show signs of being possible remnants of a former two-brooded strain. Thus, any importation of two-brooded European egg or larval parasites into Canada — with the exception of the three specific ones, just mentioned — is eventually doomed to fail because of lack of synchronization with the host. This failure will continue unless a two-brooded species of American pine sawfly occurs in the same habitat as *N. sertifer*, in which case the second parasite generation would be able to persist on this other host.

It seems possible that more promising parasites might be obtainable in North America itself. Assuming that *N. sertifer* is in fact a foreign element in Eurasia, although it has been there for a considerable time, its recent unintentional introduction into North America would appear to be of the nature of a return to its original area of development. If this is so, then the large number of native parasite species which have attacked the European pine sawfly in North America is less surprising. This complex of American parasites, however, is still rather unbalanced in that it consists mainly of cocoon parasites, with only one important larval parasite (*Exenterus canadensis*) and no egg parasites, which are often very effective in Europe against bivoltine species of Diprionidae. However, since about half the American species of pine sawflies are, like *N. sertifer*, univoltine with the same method of overwintering, the possibilities of completing this present unbalanced parasite complex of the pest in question might probably be more easily realized by an extensive search for additional parasites of the similar ecologically related species in the western States.

An example similar to this is afforded by the spruce budworm, *Choristoneura fumiferana*, the most important forest insect pest of Canada. Repeated attempts have been made to increase the efficiency of its natural enemies in Canada by the introduction of additional parasites of the closely related fir budworm (*Ch. murinana*) from central Europe. However, as far as can be judged at present, no success has been achieved. Now, Dr. H. Zwölfer of the European Station of the Commonwealth Institute of Biological Control has made a careful comparative analysis (as yet unpublished) of the parasite complexes of both these budworm species and has shown that the complex and sequence of parasites is more complete in the spruce budworm than in the fir budworm and that this is apparently due to the historical development of these species in their respective areas. Some groups of parasites, e.g., egg parasites and Tachinids, are virtually absent from the European form, while they sometimes play a significant role in their attack on the American form. These findings give rise to the conclusion that the introduction of European parasites into the rather " saturated " complex of spruce budworm parasites might be more difficult than vice versa. As Dr. Balch points out, such an assertion can never be absolutely conclusive, but it would appear that by means of this type of comparative study we might reach a reasonable degree of accuracy in predicting the consequences of our efforts at parasite introductions.

There is another group of forest insects, the holarctic, circumpolar ones, which, if studied comparatively on either side of the Atlantic, might provide some basis for a deeper understanding of the evolutionary aspects of host-parasite associations. This field of comparative studies of either circumpolar or closely related forest insects is as yet virtually unexplored. It would seem that, in addition to the " lack of knowledge of population dynamics " mentioned by Dr. Balch (*2*), it is this lack of knowledge concerning the principles of formation and composition of parasite and predator complexes which accounts for " the present little scientific basis for the selection of species of natural enemies for introduction against foreign pests. "

An instructive example is afforded by the larch sawfly, *Pristiphora erichsonii*. It is claimed by some authors that the larch sawfly was introduced from Europe into North America some 100 years ago; others, however, are of the opinion that the species is indigenous to both areas and is thus of holarctic origin. A sawfly with the ecological habits of *P. erichsonii* has usually a rich parasite complex consisting of one or more species of ectoparasites of the Tryphoninae group, several endoparasites of the Mesoleiinae group, and one or more species of parasitic Diptera (Tachinids), all attacking the larval stages. In addition it is usually also attacked by a number of cocoon parasites acting in the soil, and its eggs may also be parasitized. Such a typical complex has been found during studies on *Pristiphora* carried out in central Europe, where to date one ectoparasite, several endoparasites, including three Tachinids, and a number of cocoon parasites have been reared. In Canada, however, the parasite complex attacking this sawfly is much poorer in species and those which

FIGURE 1. – *Curled May shoot of larch due to shoot oviposition by the larch sawfly* (Pristiphora erichsonii). *Note the notch-like frass of the first instar larvae on the first needle fascicle.*

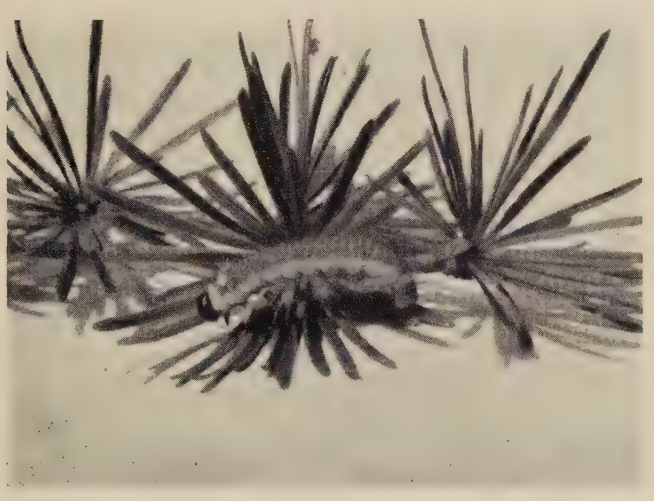

FIGURE 2. – *Full-grown larva of the larch sawfly bearing an egg of ectoparasitic Ichneumonid,* Polyblastus tener.

have been recorded regularly are either introduced species such as *Mesoleius tenthredinis*, or are of doubtful geographic status. This is obviously contrary to any theory of a circumpolar origin for *P. erichsonii*, and our present efforts to complete this poor Canadian parasite complex by further parasite introductions from Europe would therefore seem to be fully justified.

In addition to what has been said above concerning the value of comparative ecological-parasitological studies, mention should be made of another comparatively unexplored field of basic research in biological control, namely the study of insect species which are apparently already under effective natural control in at least part of their distribution area. Since it was first started, biological control has naturally been largely concerned with insect species which cause economic damage to different crops (including forest trees). Many of the species concerned are also pests in their country of origin as well as in the areas of introduction. Among forest insects introduced into the New World well-known examples are the gypsy moth (*Lymantria dispar*) and the brown-tail moth (*Euproctis chrysorrhoea*), both of which are also from time to time serious pests in European oak forests. The same applies to the winter moth (*Oporophtera brumata*), which has recently become established in Nova Scotia, and to the pine shoot moth (*Rhyacionia buoliana*), which is a serious threat to American as well as to European pine plantations.

In the case of the pine shoot moth there are in addition some half a dozen other species of the same genus endemic in Europe, and these also feed on the buds of pine trees, but they usually remain at a low population level and appear to be under adequate natural control. It would seem that a study comparing these other minor *Rhyacionia* species with the epidemic species, *R. buoliana*, might provide some insight into the reasons why the former are easily kept under natural control, whereas the latter often develops to pest proportions. A more thorough understanding of the possibilities of improving the control-system of *R. buoliana* by means of biological measures might perhaps result from such a study.

Another model of this kind is to be found in the case of the two larch sawflies, *Pristiphora erichsonii* and *Anoplonyx destructor*. Both are in fact rare species in the natural larch forests of the Alps. However, outside the natural range of *Larix europae*, both species from time to time cause serious damage to man-made larch plantations (e.g., in England), and *P. erichsonii* even does so in the tamarack (*Larix laricina*) stands of Canada, as has already been mentioned. There is therefore an apparently adequate control system in the Alps, but this system becomes unstable and ineffective in areas where the sawflies and their host plant are not indigenous. Comparative population studies on *P. erichsonii* in the Alpine larch forests on the one hand, and in Bavarian plantations on the other hand, have already shown one important mortality factor which acts differently in the two regions, namely the forest ants (*Formica* spp.). Experiments in the Alps on protected and unprotected larch branches infested with *P. erichsonii* showed on average a larval mortality of 70 to 80 percent on the unprotected branches, but of only 30 to 40 percent on the twigs protected by " tanglefoot " against these forest ants. In Bavaria similar experiments showed no significant differences in the larval mortality of the sawfly, where it was around 40 percent on both types of branches; forest ants are here completely absent. This absence of forest ants in the Bavarian larch plantations investigated thus seems to be at least one of the possible reasons for the greater abundance of larch sawflies in these nonindigenous larch forests. Unfortunately the importation of forest ants into the Canadian tamarack stands appears to be very unpromising since the swampy character of these forests would probably present an insurmountable obstacle to their permanent establishment in useful numbers.

A similar example is afforded by the green tortrix, *T. viridana*, a common oak pest in central Europe and

elsewhere. It has recently been studied in the Vosges mountains of France, where its incidence is rather low (*8*), and also in northern Germany (*9*), where it frequently reaches outbreak proportions. Zwölfer (personal information) attributes this difference to the lower incidence of larval parasites in northern Germany compared with that in the Vosges mountains. The latter area is characterized by very mixed forest stands and this is apparently a more suitable habitat for a greater variety of natural enemies than the more uniform oak stands of the German plain.

Since they deal mainly with pest species, biological control and economic entomology in general are handicapped by the very fact that their subjects of research are populations showing only varying degrees of imperfect natural control. However, pest species form only a small group of the general fauna. For example, amongst the 14 species of sawflies feeding on Norway spruce (*Picea abies*) in Europe, only one is considered to be a common forest pest and this only in nonindigenous spruce forests, three others have occasionally been recorded as of minor importance, but the majority are quite indifferent, as Thalenhorst has shown (*10*). It would appear that the current theories of natural control and particularly the models of Nicholson (*11*) and of Lack (*12*) are not very conclusive when applied to scarce species such as these. There is never any shortage of food for them, nor do the factors keeping them under more or less stable natural control seem to be necessarily density-dependent in their action. Yet such species comprise the great majority of insects (and other animals too), and this would seem to indicate very forcibly that a study of these indifferent species is essential for a better understanding and improved use of the methods of biological control, an opinion which had already been emphasized by the late Prof. Eidmann in 1949 (*13*).

It has been postulated by Thienemann (*14*) in his second biocoenotic principle that in a plant and/or animal community very rich in species, the incidence of the different species is usually low, whereas in a community poor in species, the single members often occur in large numbers, such a community or biocoenose being less stable than the former. This principle might also be justifiably applied to forest communities in general and to their insect fauna in particular. Tropical rain forests, for instance, enormously rich in plant and animal species, are very stabilized eco-systems, and insect outbreaks in virgin stands are virtually unknown. Exactly the opposite is seen in forest types such as those of pine or spruce which are usually very uniform in growth and of poor floristic and faunistic composition. Here insect outbreaks occur even in natural forests as, for example, those of the spruce budworm in Canada or the larch bud moth (*Zeiraphera griseana*) in the Alps, and such outbreaks are plentiful in man-made stands of trees such as the spruce monocultures of central Europe (*15*, *16*).

With regard to European conditions, there is a widely held opinion that the comparatively poor composition both of the European forests and their fauna is due to much more pronounced effects which the glacial periods exerted on plant and animal life in Europe as compared with eastern Asia or North America. Among the parasitic Tachinids, for example, many European species also occur in the Far East, but there are also very many additional related species which are common there, but lacking in Europe. If it is true that the absence of so many species in Europe is due mainly to these historical reasons, it is feasible that a vast field of biological control possibilities could be developed in attempting to enrich and stabilize the impoverished European biocoenoses by means of natural enemies imported from eastern Asia. There is a great number of important European forest pests which are also indigenous in the Far East, e.g., *Lymantria dispar*, *Malacosoma neustria*, *Dicranura vinula*, *Stilpnotia salicis*, *Operophtera brumata*, many species of beetles, the pine sawfly *Neodiprion sertifer*, etc. It would certainly be worth-while to initiate comparative studies of their parasite complexes, and later possibly to consider introductions to fill such empty niches in Europe as might be found to exist.

The rich fauna of natural enemies which is expected to occur in eastern Asia is also, of course, of equal interest for the biological control of forest and other insects in Canada and the United States. For this reason the Commonwealth Institute of Biological Control is planning to establish a field station in northern Japan in 1961. This will allow further progress toward a more comprehensive understanding of the ecology of forest insects of the Northern Hemisphere and of the physical and biotic factors governing them over different parts of their range. It will also improve the position with regard to future selective introductions of natural enemies into North America. Doubtless, Simmonds (*3*) is right when he says that " far from the cream having been skimmed off the general field of biological control work, we have hardly made a beginning. "

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INTERNATIONAL WOOD RESEARCH SOCIETY

The need for an International Wood Research Society has been recognized for many years. Plans to organize such a society originated with delegates to the Conference on Wood Technology. The recommendations of the Conference materialized in the founding of the Society on 27 May 1960, at a special meeting in Paris attended by 15 wood scientists from nine countries. A constitution and bye-laws prepared by a special international committee were approved, and plans for organization of the society were initiated.

The new organization is a nonprofit-making, independent international society open to individuals, private enterprises, and representatives of university and government agencies working in the fields of research, education, and industrial aspects of forest products utilization. The society is endorsed by FAO, which is to assist in the organizational stages by providing Secretariat services at Headquarters. All who joined the society in 1960 were registered as charter members.

Importance of an international society

In an area of diminishing natural resources the forests, that know no international boundaries, comprise our only renewable material resource. Over the past years there has been an awakening interest in and recognition of the need for improving wood utilization and the need for forest products research, as a means of making our forests go farther and serve the nations better.

Improving the international exchange of information and ideas among those working in the field of forest products has been frequently discussed. This need has been emphasized further by the problem of keeping abreast of findings and developments at the numerous research centers throughout the world, and in keeping up to date on an international basis on the large and expanding volume of literature. The desirability of developing an independent medium for contacts and exchange of views among those interested in improved wood utilization has become of increased importance, as well as the holding of meetings to provide a forum for presentation of papers and discussions.

Meetings

The International Wood Research Society has been organized to meet these needs, in promoting the advancement of knowledge and the more efficient utilization of wood and wood products.

The constitution provides for a plenary meeting to be held biennially at a time and place to be designated by the executive committee. Also a plenary meeting may be called periodically on authorization of the executive committee on the occasion of a meeting of the FAO Conference on Wood Technology. Special meetings may be convened on authorization of the executive committee at the time of meeting of kindred organizations. Provision is made for the development of regional groups to sponsor regional meetings.

Publications

The detailed procedures for publications are to be established by the executive committee. Publications of scientific papers are to be encouraged. Consideration is being given to a bulletin and to use of publication facilities of appropriate technical and trade journals. Information regarding organizational matters as well as scientific and technical notes and reports will be made available to all members by the executive secretary by periodic bulletins.

Invitation to membership

A cordial invitation to join the society is extended to individuals and organizations interested in the advancement of knowledge and the more efficient utilization of wood and its products. Applications for membership and other correspondence should be directed to: The Executive Secretary, International Wood Research Society, FAO, Viale delle Terme di Caracalla, Rome, Italy.

The International Importance of African Wildlife

Thane Riney
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Man is faced with the international problem of expanding population and the troubles that will overtake him unless he learns to live more wisely within his means. From a long-term international point of view, the wildlife resources of the world may be a comparatively small part of the total renewable resources, but in some parts of the world they must ultimately assume considerable significance.

It is hard to imagine our lives today without any domestic browsing and grazing animals. All around us is evidence of some way in which man has utilized animals. Our food, our clothing, indeed much of our economy is still greatly dependent upon domestic animals, the same domesticated species that have served mankind for 7,000 or 8,000 years — namely, cattle, sheep, pigs and goats.

We have advanced a long way since the days of the Swiss lake dwellers who were among the first people known to have domesticated animals. If it were possible to show one of these primitive men of about 7,000 years ago our present so-called western civilization, he would no doubt be amazed. There would be very little he could recognize — except our cattle, sheep, pigs and goats.

We have bred considerable changes into our domesticated species, but nearly 7,000 years after these species were first domesticated our most advanced animal husbandry research is still chiefly concerned with these same four domestic animals. From the viewpoint of developing improved carcass quality, of improving techniques of milking, or of harvesting an increased number of animals from limited areas of land, particularly in temperate regions, we have been amazingly successful. But in considering our, for the most part, excellent relations with domestic animals we are apt to overlook the fact that some aspects of the element of animal domestication in our present culture can cause serious trouble. There are a few phrases with which everyone is familiar, such as: " World populations are increasing, while land is being eroded out of production because of exploitive mismanagement practices or simple lack of understanding". Overgrazing, decrease in vegetation, and consequent increase in soil loss are terms familiar to nearly every informed person in the world today. The dangers associated with failure to satisfy conservation requirements are familiar to the public of most countries, but not many of us are able to recognize the role played by our traditional practices of domestication in contributing to this trouble.

The areas most susceptible to disturbance by domestic animals are mountainous areas and arid areas that border zones now successfully in use. Over the centuries, different breeds of domestic animals have been developed to suit mountainous or arid environments. There are, however, vast areas where it seems impracticable to raise cattle or sheep without putting the land out of production by loss of vegetation and induced accelerated removal of the soil. In an alarming number of mountain and arid areas the trend is for land to go out of production under domestic animal management. In

Figure 1. – *In the Rhodesias, weekly cattle dipping is necessary to minimize tick infestation. This and many other expenses required for the ranching of domestic animals would not be required in the management of wild animal population.*

Courtesy for all photographs, Thane Riney

FIGURE 2. – *The demand for meat in Africa is stimulating research as to the best methods of utilizing the African large mammal populations. One hundred natives reduced five carcasses of elephants shot for damaging maize near a remote village to bone and strips of drying meat in somewhat under three hours. The photograph was taken about 20 minutes after skinning operations had started.*

FIGURE 3. – *In the Rhodesias steenbok are associated with shrubby or forested areas bordering grasslands, for the bulk of their diet consists of low shrubs and herbs. They are thus a factor in reducing shrub encroachment and should be encouraged in many types of land use where management aims at the maintenance of perennial grassland.*

planning for the utilization of animals in these marginal areas, would it not be simple common sense to search for the most suitable animals for a particular area? Not just a new tick-resistant, heat-resistant, veld-adapted, broader-beamed breed of cattle, but an entirely different species or combination of species.

There is a vast amount of additional knowledge to acquire and understand before we learn to use marginal areas wisely, not only in order to keep them in production but to bring more and more poor land into some form of economic utilization. In each critical, each marginal area, we need to understand enough about the basic resources of soil, vegetation, and browsing and grazing animal relations to prevent humans from continuing to deplete these areas, which are of such vital importance to them. This is not a job exclusively for soil scientists, or botanists, or zoologists, or animal breeders, although all these and many other types of specialists will undoubtedly make large contributions. Before we can stabilize these deteriorating marginal areas there will have to be a type of ecological approach and integrated teamwork which we have yet to see in biological or agricultural science. It will take time to acquire this knowledge and understanding. Perhaps 50 years, perhaps 200 years. How much do any of us understand of the basic animal, the cow or sheep, on which we have for centuries been superimposing our man-made ideas of domestication? Where domestic animals are concerned this may call for studies of free-ranging unmanaged populations much as one would study a population of wild animals, in order to assess the natural tendencies of our domestic breeds under different types of environment and so compare them with wild animals in the same environment. Are there basic principles of behavior and utilization to be learned from wild animals which may contribute to our understanding of domestic animal economies on marginal lands? There is already enough evidence accumulating on wild browsing and grazing animals to answer this question with a positive "yes".

Areas of research opportunities

On an international basis several parts of the world have research opportunities which, when exploited, may result in major contributions to the eventual understanding required.

North America constitutes one of these areas. It is a north temperate area that, especially within the

last 200 years, has gone through a period of colonization, of overuse of the land by colonizing European pastoralists, of devastation of vast areas particularly in the dry western regions. Eventually it has become the subject of government concern, intelligent public pressure and programs of research, of demonstration and of education at all levels aimed at achieving increased stability of soil and vegetation. It is here that, within the past 50 years, the subject which is called range management has developed. This development may well be a major contribution already under way toward this eventual understanding that is so urgently needed. Here in temperate and Mediterranean-type climates a study has developed not of vegetation alone or of cattle or sheep as subjects on their own but a study of the ecological relations between these animals and their environments. Range management deals with such problems as determining the permissible balance between numbers of cattle on the open range, and the amount of range grass produced each year to carry these cattle, and ensure their survival, while maintaining the value of the land, even in severe winters or in drought years. Various techniques have been developed for placing these relationships on an objective basis and already a great deal of technical literature has built up which deals with animal-vegetation-soil relations in temperate regions. This does not imply that work accomplished in Canada or the United States should be duplicated everywhere in the world. It does, however, form a convenient body of reference in the literature which can serve as a criterion for other areas and it is important to mention it as a basis for wildlife management, for wildlife increases the economic value of many of the rangelands in North America, where animals such as deer, bear and antelope are incorporated within many types of land-use programs.

In parts of western and northwestern Europe certain forms of land use, including forestry, pastoralism, and wildlife utilization, have been in existence for several centuries, and large areas have remained under continuous human occupation without loss of productivity or destruction of conservation values. An understanding of such areas is very important and it is to be expected that when appropriate ecological studies produce information on these important relations between soil, vegetation, climate and patterns of continuous land use including browsing and grazing animals, the nature of this stability can be compared with, and add to, the significance of similar information in many other parts of the world.

At the 1960 conference of the International Union for the Conservation of Nature and Natural Resources in Poland, the delegates were enabled to visit a large forest which had been undisturbed for several centuries and were delighted to see that the Polish scientists are doing very thorough and painstaking work of broad scope in trying to assess the complex but comparatively balanced economy of this primeval forest. They are using it — as many countries could well use their national parks — as a biological check against adjacent utilized lands.

Although it may seem somewhat academic for eventual

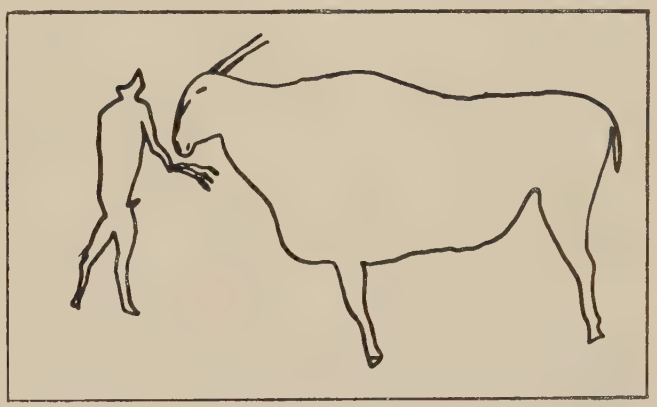

FIGURE 4. – *Bushman rock painting of man feeding eland. This ancient record does not of course imply that the Bushmen were aware of the potentialities for domestication as we understand them today but it seems likely that they well knew the ease with which eland can be tamed.*

FIGURE 5. – *On several Rhodesian ranches, eland and cattle are being herded together on an experimental basis. This eland, in its second year, is shown returning to the kraal in the late afternoon after having spent the day in the vicinity of the grazing cattle. In the dry season, in this area, the eland feed largely on shrubby material, while the cattle feed on the sparse grass cover.*

understanding of browsing and grazing ecology on an international basis, Australia should be mentioned as a potentially important area for study. In the north temperate regions and in Africa there is a great variety of species of browsing and grazing animals, yet almost all of these are ungulates of various types and most are deer or antelope. While generalizing about browsing and grazing animals on an international basis Australia must be included, for here, in a quite different zoological group, the marsupials, we have browsing and grazing ecological niches occupied almost entirely by marsupials. Here, wallabies, phalangers and kangaroos take the place in the environment of deer, squirrels and antelope in other parts of the world, and already marsupials are being considered as a potential harvestable resource in certain Australian regions inhospitable to present forms of pastoralism.

New Zealand is a very small area by comparison with these other areas, but is nevertheless an important area for study. It is an almost perfect test tube for certain types of fundamental studies of browsing and grazing animals, for before human occupation, New Zealand had no native mammals except two bats. Into this animal vacuum as it were, all the domestic animals were introduced, and ten different species of wild ungulates, mainly deer. This is an ideal opportunity for studying liberation behavior between a variety of browsing and grazing animals, the selection of habitat, the types of dispersal exhibited by the various species, the beginnings of migration and the development and definition of animal problems.

FIGURE 6. – *Although the giraffe eats grass, especially in the early part of the wet season, it browses during the period of the year when grass is critical to mammals like zebra and wildebeest, which are largely grass-dependent. Most of the giraffe's food comes from levels starting near the upper levels of browse for other species and continues up to over double that height, thus utilizing a layer of shrub and tree twigs that could otherwise be reached only by elephants.*

Campaigns to eliminate animals have been operative for over 20 years, during which time some consistently shot populations have increased and others have decreased, while few have been eliminated. New Zealand thus provides excellent demonstrations of response of wild deer populations to various intensities of shooting and to various shooting procedures. The principles formulated from this evidence should be of value to other countries who wish to develop schemes for harvesting wild populations so as to achieve maximum productivity.

Since in many parts of New Zealand only one or two species of mammal occur, there are available for study extremely simplified ecological situations where it is possible to conduct types of investigation that would be far more difficult, expensive and time-consuming elsewhere. Because these islands have a great variety of climatic conditions they are ideal places to study the effects of temperate environments on free-ranging wild ungulate populations and on free-ranging feral cattle, sheep, pigs and goats.

But Africa offers the ultimate opportunity for studying large mammals. From Africa may well come the greatest contribution of all for, while New Zealand holds the simplest of ecosystems, Africa offers the most complex. The amazing thing about Africa is that for the past million years there has been a galaxy of life which has survived virtually intact up to the present century, with very little change in form since the Pleistocene. These animals have survived in the presence of African populations and their various ways of life, in spite of drought years and flood years, and in spite of periodic fires. In the process certain parts of Africa have been producing weights of animals per square mile that not only compare favorably with domestic animals on the same type of land, but which have caused practically no damage to the land during this entire time. This phenomenon of comparative stability in arid areas is worth understanding while it is still there to understand.

Each of the African species fits like the pieces of a complex jigsaw puzzle into its own place in the total environment. Some animals, like the sitatunga and lechwe, prefer wet ground; others, like the gemsbok and addax, tolerate extremely dry conditions. Eaters of grass like the wildebeest and zebra exist together, each following its own pattern of life. Browsers like the steenbok and duiker utilize the lower vegetation levels; kudu, buffalo and eland use higher levels, and the tree topping giraffe has special advantages for high altitude browsing. Predators not only help to reduce upsurges in animal numbers, thus preventing overuse of vegetation, but also contribute to wider distribution of feeding activities. The world's first forester, the elephant, often becomes a dominant influence in the environments where it is found. Elephants push over trees for their own use, but incidentally make higher leaves available to smaller animals and the fallen branches often protect bits of ground on which grasses and young shrubs and trees can establish themselves. Elephant

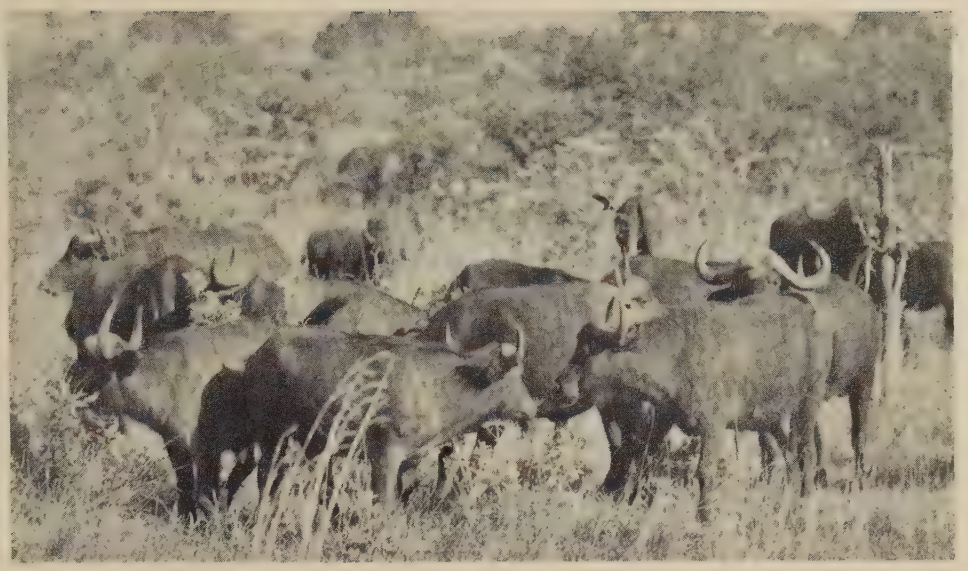

FIGURE 7. – *The buffalo is one of the species that can subsist largely on shrubby material near the end of the dry season, weighs more than cattle, and like many other large African mammals is more suited to drought conditions than cattle, as well as being more tick-resistant and indifferent to the decimating effects of the tsetse fly.*

droppings spread the seeds of many trees, as do the droppings of many antelope. Elephants digging for water in dry stream beds often make water available to different species who would otherwise be without. There is no end to these countless complexities and interrelations. Practically none of these relationships have been properly worked out and documented or understood.

The land in turn responds in a somewhat different way to each species and throughout the entire complex system a stability of existence has continued in many parts of Africa since the Pleistocene.

Wildlife use

How can a growing knowledge of this age-old stability and productivity of the land best be utilized? The concepts of national parks to preserve land and its plant and animal communities for recreation and study are already known and used in many parts of Africa. In addition, the idea of domesticating wild animals or of harvesting wild populations of African mammals has been growing in popularity in recent years, particularly in areas where domestic animals are unsuited to the African environment, in marginal areas and in many areas still unallocated to any form of land use. This positive approach may involve the use of wild animals to add supplementary values to existing forms of land use in certain areas. On a national basis the concept of utilization means supplementing (not replacing) the very real economic and aesthetic values achieved by protecting indigenous populations in national parks and reserves.

A new species can be domesticated for meat and skins and other products; the wild populations can be harvested and it is possible to be optimistic that something more suitable will eventually be devised for many of the critical arid and mountainous areas in the world. Animal utilization as a science is as yet in its early stages. At present man is using the same pastoral animals that were used 7,000 years ago. Yet wild animals the size of sheep and larger are widespread and numerous. They occur naturally throughout the temperate and tropical regions in nearly all types of country and situations. Reindeer and caribou, for example, extend north nearly to the furthest limits of land. Several antelope in Africa are apparently very well adapted to water-scarce regions. One breed of wild sheep is found as high as 20,000 feet up the slopes of the Himalayas.

An important consideration for the increased utilization of African wild species is their better adaptation to the African environment, better even than that of the latest domestic breeds of cattle or sheep. This adjustment is one well proved over a testing period of thousands of years. Many wild species are perfectly adapted to kinds of country that cattle or sheep either cannot tolerate or barely tolerate, yet there are many mountainous or desert environments which can tolerate a wild species indefinitely. In many of these same areas only a few domestic animals can disturb the environment so much that vegetation does not renew, soil loss accelerates, less water is retained in the soil, the water table lowers, streams become dry progressively earlier in the season and eventually the land goes slowly or rapidly out of production. Unfortunately, it is possible to continue to produce cattle or sheep in good or fair condition, on an economic basis, all through the early stages of this process of degradation of the land. It is on the basis of soil-vegetation stability that all future types of land use must be built, whether this means a slight change in pastoral economy using the domestic animals of today, whether it includes wild animals as an accessory form of utilization, or whether it means the development of wild animals as a major form of utilization on some lands.

There is a Bushman painting from a cave in eastern Cape Province, South Africa, which shows a Bushman-type figure holding out a bunch of aloes to an eland. Dr. Livingstone, about a century ago, noted the African eland in his journal as an animal well adapted to the country and suitable for domestication. This large

FIGURE 8. – *This sleeping lion is seen resting in Wankie National Park, Southern Rhodesia, about 50 yards from a buffalo killed the previous evening. Some of the ranches proposed for the utilization of large mammals border national parks where, under the total protection starting about 30 years ago, overpopulations of many large mammals have already been built up. Under these conditions, and as a measure to protect ranches more remote from the parks, a certain percentage of the large predators could probably be included as they are excellent distributors of grazing pressure.*

antelope has been domesticated by interested ranchers in many parts of Africa but as yet no serious attempt has been made fully to exploit its great economic possibilities. Cattle and perfectly tame eland have been seen herded together, yet hardly competing for food, for the cattle concentrated on grasses, while the eland browsed on shrubs and trees. It is conceivable that in some types of forest country now steadily deteriorating under some form of cattle-raising program, cattle could be reduced sufficiently to allow processes of recovery to start, and the raising of eland would still allow the environment to be used on an economic basic. This is an example of the kind of practice that might expand when we learn to work within the limitations of our critical environments rather than going against them.

Springbok, impala, eland and ostrich are utilized for their meat, biltong and skins in South Africa as domestic or semidomesticated animals. One of the major activities south of the Limpopo is the restocking of species locally extinct, back into the areas from which they have been eliminated.

The further domestication of wild animals should at no time be considered a panacea for automatically solving all pastoral conservation difficulties. Any new domestic animal is a potential source of trouble, just like the present ones and for the same reasons. After all, this business of domestication means having the animals nearby under usually intensive management, to suit man's needs. Animals are moved in and out from kraals and changed from one enclosure to another at certain intervals. They are sheared, polled, dipped, docked, inoculated, but most important of all, concentrated in a smaller area than usually happens with wild animals. The unfortunate result is that, particularly in mountainous or arid regions, colonization with a pastoral European economy commonly results in steady degradation of the land.

Domestication of a wild species is but one of the two main potential types of utilization. The other approach is to develop systems of harvesting wild populations without domesticating them, using at the most a light management program. This is not a new idea. Animals have probably been hunted, snared, speared, dropped in pits, transfixed with arrows or hamstrung for as long as man has been on this earth. But with today's jeep, helicopter, and refrigeration facilities, the potential uses of wild populations in Africa are on a plane which would have been unimaginable even a few years ago. There are many practical obstacles to overcome in the development of the utilization of wildlife, just as there are at some stage in the development of any other renewable natural resource. Future broad avenues for development will involve development of marketing, transportation and preservation techniques, the modification of existing, and development of new, harvesting techniques, and the continuing development of techniques for maintaining a stable and suitable habitat for the most productive combinations of harvestable animals.

There are also enormous educational tasks ahead: education at various levels of administration to stimulate group thinking by men dealing with many forms of land use, each with its own marginal land utilization problems; education at an almost disheartening variety of cultural levels, for conservation must develop in an integrated way that makes sense to the society in need of conservation practices or the educational effort has little chance of being effective; education for a variety of cultures outside Africa to stimulate intelligent help in the form of tangible help, with research specially adapted for the immediate needs of the country in question. The task is admittedly enormous, but it is vital. Research on large African mammals has considerable urgency. The urgency results partly from the expanding population in Africa and the consequent priority attached to searching for more suitable forms of stable and productive land use. Many large mammal species have been eliminated over vast areas by a combination of shooting and drastic changes in habitat associated with the comparatively recent introduction of large-scale exploitive forms of land use. The great variety of species available in areas where rich assemblages of large mammals still abound is to be duplicated nowhere else in the world, yet knowledge gained in Africa, through elucidation of basic ecological principles involving different combinations of browsing and grazing animals, may significantly contribute to the understanding and solution of marginal land problems in many other parts of the world.

Although at present the actual numbers of research workers in the field are small, they are increasing, and future research on these large African mammals may prove to be one of the most important fields of study biologists will have to deal with in the present century.

Some Problems of Regional Planning in Forestry

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The problem of basing forest policy upon the differentiation of the natural and economic factors of forestry is strictly related to the problems of co-ordinating the growth trends of industry, agriculture, forestry and other branches of the national economy. A further important factor influencing those trends is the increase of population and of its standard of living.

The problem of determining the regional economic bases of forestry in general, and its natural bases in particular, is of great importance for the national economy as a whole. This has been proved by the experience of the U.S.S.R. as well as of the United States of America, for example, in the well-known results of the Tennessee Valley experiment. As for research on division of a country into natural (physical) regions, Russian and Finnish works are of considerable importance. Polish scientific forestry literature has dealt for over a century with problems of geognomic and typological research. In 1850, A. Polujanski, a well-known Polish forester, produced a four-volume work in which he examined the relationship between regional forest economy and industry and agriculture, also taking into account the level of education and the earning possibilities of the rural inhabitants.

In the 19th and 20th centuries, research on a division into natural (physical) regions has developed widely, and resulted in a series of projects concerning typological classification, as for instance the classification project of Jedlinski and Chodzicki before the second world war, and that of Dreszer, Chodzicki, Wloczewski and Mroczkiewicz after it.

The division of a country into "spheres" and natural (physical) districts, proposed by Mroczkiewicz, now forms the basis of management instructions and of all principles of silvicultural planning in Poland.

This article embodies suggestions for reconciling opposing tendencies that often hamper the development of forest management. It deals mainly with the gap between natural productive possibilities and the economic tasks facing forestry. Mroczkiewicz suggested the division of the country into eight natural forest spheres — extensive areas each corresponding to certain distinct silvicultural characteristics. This division ensures optimum productivity by basing silvicultural planning on soil and forest type characteristics for the sphere concerned. By fixing the extent of those spheres, it is possible to determine the bases of natural forest production. Modern scientific literature offers a number of methods for determining the main lines of forest typology, e.g., the works of Braun-Blanquet, Sukachev, Aichinger, Pogrebniak, Paczowski, Niedzialkowski and other authors, which represent both the physiological and the bio-geocenotic approach.

Division into regions

In order to determine the tasks of correct forest management, it is necessary to take into account:

1. production possibilities,
2. conditions of economic production that will influence the development of forestry,
3. production objectives, economic and natural (physical).

The realization of these postulates would be obtained through:

1. the establishment of natural spheres determining the possibilities of biological production,
2. the establishment of economic areas to be devoted to forest production, in order to fulfil the tasks and objectives of production.

Research on a division into regions ought to be carried out by means of analysis as well as synthesis, based upon static and dynamic examinations of the development of forestry in its relationship to the other branches of the national economy.

It is necessary to remember that, when examining an individual forest unit, we must consider it as an element of a bigger unit, the latter being an economic region that has not developed by chance but shows certain regular features characteristic only of that special region. This relationship cannot be properly appreciated without determining the economic regions.[1]

The examination of these problems can be conducted from the viewpoint of the development of forestry or of industry, which is the most antagonistic element in relation to forestry. An important task of forest economy is the examination of the trends of economic development as a result of the influence of the economic area in which this development is proceeding. That development, it should be added, must be examined in

[1] Definitions of "region," "district," etc. are, given under the section *Economic regions.*

various ways. Forest science and especially forest economy have developed late, and their development has always been completely subordinated to the needs of practical analysis. Unfortunately, investigations on the relations between forestry and other branches of national economy are not yet sufficiently advanced in most countries. The development of synthesis, i.e., applied economics, can only proceed on the basis of the above-mentioned analysis. The rules and forms applied by forest legislation and forest management are effective only if consonant with regional needs and development trends. Examination of the geographical and economic situation, which exerts a prime influence on the development of forest economy, ought to form the basis for any implementation of forest policy and forest management.

This influence is particularly evident in Poland. It is very noticeable that the percentage of forest land is far higher in the west than in other parts of Poland. Furthermore it has not decreased in those areas, nor in Germany, since the end of the 18th century; indeed, the percentage of forest land has risen slightly there, whereas elsewhere in Poland it has steadily and rapidly fallen. In that period it fell by nearly 50 percent, and in the 20 years between the world wars, it fell by about 8.5 percent.

The explanation of this fact lies in the historic development of the economy of those countries. The division of Germany into numerous small countries in the 18th century and the existence of large self-sufficient feudal properties caused a considerable (though originally unintended) seclusion of economic regions. These small states were developing independently side by side, and in some periods of the 18th century were even separated from each other by customs barriers. Consequently, each had to develop all the branches of its economy and simultaneously to safeguard its forest area. The existence of these small but autarchic German states and of great feudal properties often resulted in the formation of widely differing systems of forest legislation — systems adapted to the regional peculiarity of the forests in the respective countries — and until recent times, the forestry of those regions remained in an almost unchanged form.

Economic regions

Under the concept of an economic region, one must understand a certain area of a country in which all the interconnected productive elements have formed themselves or are forming themselves in a certain visible manner. Division into regions implies the existence of boundaries. The boundary of a region is surely only an outward expression of these active elements; it is fixed along the line of a steadily changing balance of forces. Although such boundaries are not traced on the territories, they have a real existence. In the rest of this article, the term "region" will be used for a group of areas showing similar economic conditions; "sphere," will mean a group of areas of similar natural (physical) forest qualities; and "district," areas of similar natural (physical) as well as economic qualities. This gives a classification into regions and spheres. The division into regions and spheres is of course not identical with administrative divisions. Poland, for example, is administratively divided into 17 units (*wojewodztwo*) with, in addition, four big cities.

From the literature dealing with this problem, it appears that there have been tendencies to delimit economic regions on the basis of similar statistical qualities, as comprising areas of a very similar character.

Geographical situation, and the economic activities resulting from such a structure, were also taken into account when those economic regions were delimited. Since the beginning of the 19th century, the city and its sphere of influence have been considered as a single region. Other systems of thought defined a region on the basis of labor division, and of exchange in the framework of a common market.

A very important influence on the formation of regions is the intensity of agriculture practiced; its degree of intensity is often connected with, and heightened by, the establishment of industrial centers. The intensity of agriculture exerts, *inter alia*, a great influence upon the structure of forestry, intensive agriculture causing a considerable increase of demand for certain definite types of wood. As further influences, we may also note the increased danger of livestock grazing in the forest, the problem of manpower, and so on. I shall not here analyze demographic problems and their fundamental influence on the structure of the region. I only wish to stress that:

1. Delimited regions must ensure such a distribution of productive forces as would allow a regional balance between the development of means of production and the increase in the labor force.
2. Regions must aim at a certain balance in relation to each other, as underdevelopment as well as overdevelopment of a region is not desirable, partly because extremes endanger the balance between economic and social development and cause economic losses.
3. The optimum development of a region must be fully integrated, as only thus can full utilization of economic reserves, lowering of transport costs, more profitable production, and better employment possibilities be achieved.

Economic regions perform certain functions within the framework of the whole economy of a country (e.g., an industrial region, or one of intensive or extensive agriculture). Agricultural policy has widely developed the investigation of systems of classifying the intensity of agricultural land use. Gerner establishes certain distinct gradations: e.g., the first degree, less than 25 percent of root crops, and over 30 percent of pasture; the fourth degree, over 15 percent of root crops, 35 to 50 percent of grain, and 35 to 50 percent of pasture. With further degrees, the proportion of pasture increases

— up to 85 percent in the ninth degree — while the proportion of grain decreases. These studies, which have been carried out in Western Germany, show that the lower degrees of agricultural intensity are to be found mostly (but not exclusively) in the regions with a low percentage of forest land, the higher degrees in the regions where this percentage is high; for instance, the well-known mountain spa Bad Tölz belongs to the ninth degree, with over 90 percent of pasture and 60 percent of forest area in the district. I mention problems unknown and unexamined in many countries in order to demonstrate that the percentage of forest land is most probably the factor that increases the intensity of agriculture and causes an improvement in the balance and level of agricultural practice.

For many centuries livestock grazing and the state of game hunting have decisively influenced the level and the state of forestry. Legal prohibition of grazing is not sufficient. Agriculture as a whole must reach a higher level of productivity if it is to create proper conditions for the development of forestry. In Denmark, for example, the existing large imports of synthetic fodder and the increased exports of butter have contributed basically to a considerable increase in the area, value and standard of management of the beech forests. All this proves that there exists a need to start synoptic research, first to determine the mutual relationship between the percentage of forest land, population density, percentage of area of different agricultural crops, and then to examine the relationship of the amount of livestock to the forest area. With the development of agricultural techniques together with the improvement of agriculture and silviculture, and with better methods of utilizing raw materials, a dynamic balance will develop within the framework of a region. In such circumstances, the growth of the region has a systematic and complex character, in place of the partial and spontaneous growth in the past. Studies on the formation of economic regions, carried out in Poland, furnish numerous data on the influence of industry upon forestry. Figure 1, relating to the Katowice administrative unit (*wojewodztwo Katowice*) which has a high degree of industrialization, shows that:

(*a*) forests located in the immediate neighborhood of industrial centers are damaged by coal and sand exploitation, insects, and smoke;

(*b*) forests situated farther from industrial centers are endangered by other factors;

(*c*) only forests situated to the north and south of the centers have remained healthy.

This observation also determines the aims of forest policy in this district, which are: to increase the healthiness and resistance of forests by the introduction of broadleaved species, and to adapt them better to the requirements resulting from the industrial character of the administrative unit and the considerable population density, by augmenting their amenity and tourist importance.

FIGURE 1. – *Diagram of the Katowice administrative unit, showing the effects of industrialization upon forestry.*

When speaking of economic regions, it is necessary to stress that they are different from industrial regions, which were delimited and are still selected on the basis of old or newly discovered reserves of raw materials, for example, the Turoszow industrial center recently established on the basis of coal, the Tarnobrzeg center on the basis of sulphur. Industrial regions have also arisen in the vicinity of places where industry has existed for a long time, thanks to a peculiar structure distinguishing them from other areas surrounding them (for example, the textile district of Lódź). Industrial districts, especially the larger ones of great industrial intensity, are systematically driving the forests further away, leaving only a few forest fragments for recreational purposes. This is most evident in the Katowice unit; it may also be observed in the Krakow unit. Only in the Bydgozcz unit have the separate branches of production maintained a certain balance, although destruction of forests by intensive agriculture may also be observed there (Figure 2).

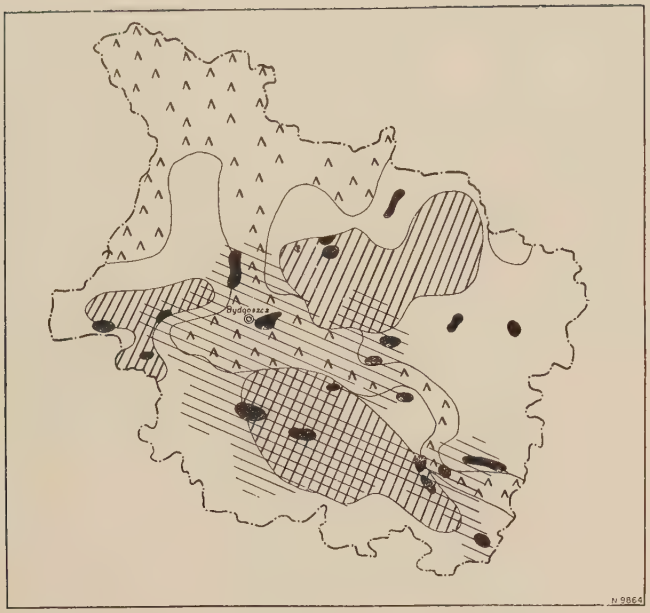

FIGURE 2. – *Diagram of the Bydgozcz administrative unit, showing how the separate branches of production have maintained a balance although there has been some destruction of forest because of intensive agriculture.*

Forests with preponderance of wood industry
Areas of intensive agriculture
Industrialized area
Appearance of important raw materials

The gradual driving away of forests and pressure upon forestry can be clearly seen when studying, on a map showing future plans, the aims and trends of Poland's economic development. The increase of the area of agricultural cultivation is seriously limiting afforestation plans. In the past, land-use planning did not take forestry problems sufficiently into account, and subordinated the increase of the area of forests and their proper location to the growth of industry and agriculture. This ultimately had a bad effect on the growth of industry and agriculture themselves.

An example of such disproportionate development can be seen, for instance, in the plans for increasing the low percentage of forest land in the administrative unit of Lublin (19.9 percent) — an increase, by 1975, of about 10 percent whereas that of livestock is planned at 62 percent. (The latter may increase the serious erosion appearing in that area.) Such disproportionate growth may get still worse if forestry does not assume its proper importance in the Polish economy. However, there is also the Koszalin administrative unit which shows a high percentage of forest area. Here the development plans aim at the best possible integrated utilization of wood. Woodworking is the main industry. Similar plans for well-wooded regions are being realized, on a much larger scale, in the U.S.S.R., where the general plan of forestry organization and wood utilization comprises, for example, in the Perm region, a production of many millions of cubic meters, providing for the complete utilization of about 1.7 million cubic meters of waste wood and wood of minor value. Other well-known examples of such trends are the Svenska Celulose A.B., Sundsvall, and the Hellefors Brooks Company in Sweden.

Forestry planning

As mentioned at the beginning of this article, the classification of Polish forests into economic spheres of similar natural (physical) and economic structure is based upon an already existing natural differentiation, and upon already accepted plans for the division of the country into economic regions.

This economic division forms part of the aims of general planning within the area, planning which has been implemented on the basis of the following data: national income *per caput*, population increase expected up to 1975, participation of regional total industrial production in the total production of the country, estimate of increases in investments for raising agricultural productivity *per caput* in the same period, and so on. As can be seen, the data were of a static as well as a dynamic character. Moreover, conditions of historic growth, the transport system, etc., were taken into account where necessary. On this basis, the country has been divided into a few large economic regions. Together with these data, further factors characterizing forestry in these regions were determined, namely: percentage of forest land, what proportion it constituted of the whole forest area of the country, percentage of growing stock in the given region, expected growth of forest area up to 1975, volume of growing stock in the region in the same period.

TABLE 1. – COMPARISON OF CHARACTERISTIC DATA BETWEEN REGION 2 AND REGION 4

	Region 2 (southeast)	Region 4 (south)
Per caput national income [a]	87.1	119.5
Percentage of participation in the total industrial production of the country	11.1	45.2
Percentage of increase of population [b]	137.5	133.7
Increase of agricultural production [b]	141.2	113.4 [c]
Increase of cattle breeding [b]	177.4	154.3
Percentage of forest area	20.8	26.5
Percentage of the total forest area of the country	20.7	19.0
Percentage of the total growing stock [d]	19.2	24.2
Density of forest road system, km./ha.	1.97	1.80
Dynamics of the growing stock [e]	111.6	104.4

[a] Average national income, 1958 = 100.
[b] 1959-1975.
[c] The actual average level is higher than in Region 2.
[d] Industrial wood only.
[e] Industrial wood only. 1959-1975, 1959 = 100, providing the allowable cut.

FIGURE 3. – *Diagram of the southern Region 4, showing its division into districts and spheres.*

Boundaries of regions
Boundaries of districts
Boundaries of natural spheres
V, IX... *Natural sphere*
a, b, c... *Economic and natural districts*

As an example, Region 2 (the southeastern region of a rather agricultural character) is compared in Table 1 with Region 4 (which is intensely industrialized).

As the Table shows, the important economic differences between the two regions cause forestry production in them to proceed in two completely different ways, with quite different aims. Such economic division was applied to the map of the country and related to the existence of the eight natural (physical) spheres, which were discussed at the beginning of this article. Figure 3 shows, as an example, Region 4 (southern economic region) in which the boundaries of natural (physical) spheres are drawn; in this example are seen the extent of the Sudety sphere and in part of the Carpathian and Silesian spheres. Within the framework of each region the whole area has a similar character from the economic point of view, although within one region considerable differences may be noted. For instance, the area of Sphere VIII is characterized by similar economic and natural (physical) qualities, as it belongs to the same region and the same natural (physical) sphere. Nevertheless, within a region or sphere there exist differences

TABLE 2. – ECONOMIC AND NATURAL DIFFERENCES BETWEEN DISTRICTS IN REGION 4

District	Sphere	Physical and economic qualities
a	VI	Small agricultural areas near the boundary. Intensive agriculture. No industry. High percentage of forest land. District in the pine, oak, fir, beech, spruce and larch area. Mostly coniferous forests, with some broad-leaved trees. Soils formed on moraine bases.
b	V	This area comprises the greater part of the region. In the center, mostly highly intensive agriculture; on the outskirts there are also areas with intensive agriculture. Intensively industrialized district. Two areas of agglomerated heavy industry in the eastern and southwestern part. (A part of the Upper Silesian coal basin and the Walbrzych industrial center.) Besides the Opole industrial district, the great industrial center of Wroclaw and many other smaller centers. District with high percentage of forest land, containing the natural forest area of the Silesian sphere. Great geological variety of soil, from diluvial formations through black humus to loose sands and dunes. Within the range of all important species of forest trees - spruce, pine, with some oak, beech, hornbeam, fir; on better soils - beech and mixed hornbeam and oak forests.
c	VII	Sudety area, containing mainly the industrialized part of Lower Silesian coal basin. Great agglomeration of municipal industrial centers. Intensive agriculture. High percentage of forest land. District contains the natural forest area of the Sudety sphere. Geological structure very varied - mostly granite and slates or schists. Soils also very variable, depending on the parent rocks. Spruce forests in the mountains, while the lower parts have some beech, fir, spruce, larch and maple. At the foot of mountains, forests of many species with beech, fir, spruce, pine and oak.
d	VI	District of extremely industrial character (Katowice - Krakow district). Big group of industrial towns. Mostly intensive agriculture (highly intensive in the central part). Some forests of lesser importance. Soils composed of hard lime. Beech is the typical species in this district; also oak, fir, spruce, rarely pine.
e	VIII	Area at the foot of the Carpathians. Northwestern part of industrial character; also several separate industrial centers. The rest of intensively agricultural character. Greater proportion of forest than in *d*. Soils formed on sandstone, loam and slates or schists. Forests of many species with fir, beech, spruce, larch, maple; in the transition zone, also pine and oak.
f	IX	Mountain area of the Carpathians, devoid of industry; intensive agriculture. Forests of great importance, zone of spas, recreation and tourist centers. Poor alluvial soils, in the mountains shallow soils on granite. The upper part, in the range of spruce and stone pine, has spruce forests; the lower part has some beech, fir, spruce and maple and larch. Dwarf mountain pine on peat bogs.

of secondary importance; for example, at the southern boundary of this region there are mountain forests important for recreation and tourism; there are also many farm forests with intensively developed pasture. The boundaries of districts are boundaries of natural (physical) spheres or boundaries of intensive agriculture, or of industrial regions. Thus six economic and natural districts have been delimited in the southern region; over 20 districts have been delimited in the whole of Poland. Table 2 illustrates the economic and natural (physical) differences between the districts of the southern region.

The division into districts does not coincide with the administrative division, but the boundaries of this region strictly coincide with the boundaries of three administrative units; a connection therefore exists between the existing administrative division and the proposed economic one. The division into districts is chiefly determined by the fact that every delimited district *as a whole* forms part of a determined natural (physical) sphere.

Each district thus has similar economic and natural (physical) conditions, and helps to overcome contradictions existing in its sphere. The method of district delimitation described above may be applied to state forests in the form of obligatory directives, as well as to forests not owned by the State by indirect influences and methods available in forest policy. This question will be discussed later in this article.

Production zones

The division of forest land into economic regions must constitute the basis for the determination of industrial regions covering sawmills, plywood, fibreboard, particle board, pulp mills, etc. The starting point in this determination is, on the one hand, the location of already existing woodworking factories and on the other (as practical possibilities of production), the reserves of raw materials in the given region. Taking into account the mechanized conversion of wood (sawmilling and other branches of the timber industry), the actual productive capacity and available raw materials have to be analyzed, taking into consideration only the varieties suitable for manufacture in these factories. The result of the analysis in the example given shows that there exists in all the units, save three only, a great surplus of sawmill productive capacity over the productive potential of the raw materials available.

With pulp production, the situation is different. The country possesses great possibilities for expanding the fibreboard and pulp industry. Potential reserves of raw materials for these industries exceed the manufacturing capacity of the existing factories in several administrative units. On the other hand, three southern administrative units (the Katowice, Krakow and, to a lesser degree, the Opole unit) possess factory capacity for modified wood products far in excess of the possibilities of their reserves of raw materials. Further development of the fibreboard, particle board, and pulp and paper industry would allow the utilization of over one third of the above-mentioned quantities of wood as raw materials. Proper location of these types of factory will be possible on the basis of a proper location of wood industry in general.

In summing up this analysis of a division of the country into economic and natural (physical) forest regions, the aims of this division and its practical importance must be emphasized. Besides the aim already mentioned of determining the proper relationship between forestry and other branches of national economy, a regional division of forests will allow the real aims and development tasks of forestry to be determined:

1. Economic aims as a whole: dealing with the growth trends of forestry in the region, i.e., determining the main tasks of production, protection, investment trends, and so on.
2. Aims of forest management in particular: the determination of the relationship of forestry with other branches of the economy and the detailed tasks of each estate, starting from common economic trends.
3. Production aims: the determination of tasks under various aspects of productive forestry, with due regard for their productive ends; classification of soils in order to determine properly the correct species composition of forests; determination of optimum forest structure, etc. Determination of production possibilities from the physical point of view, as well as of economic tasks, will make possible the choice of species most suitable for afforestation.
4. Special aims from the point of view of water management, such as recreation, educational, scientific and protection purposes.

These aims should be achieved on the basis of the above-mentioned division into physical and natural (physical) regions. They should emerge from the prospective growth plans of the various units and regions, thus forming a link between the aims of forest policy and forest management.

The following example shows the practical importance of the method described:

District a. According to typological conditions: on bad soils nearly 90 percent pine (*Pinus sylvestris*); on better soils 10 to 30 percent pine mixed with birch (*Betula pubescens*); 30 to 50 percent spruce (*Picea excelsa*) on certain soils; on the best soils 10 to 15 percent of oak (*Quercus pedunculata*).

Production aims: on bad soils, pit-props and pulpwood; on better soils, partly saw logs with a rotation not longer than 100 years. The production of this district will, if possible, be adjusted to the developing trends of industry in the neighboring district *b*. Over the greater part of the forests, clear-cutting in strips 60 to 80 meters wide and 2 to 4 hectares in area. Classi-

fication of forest types in the whole country is, of course, much more differentiated and more detailed than that shown above.

District f. 40 to 60 percent beech (*Fagus sylvatica*); 20 to 30 percent fir (*Abies pectinata*); 10 to 20 percent larch (*Larix polonica*); according to soil conditions, also spruce.

Production aims: protection of the water regime, recreation, tourism, etc. High rotation (up to 150 years), mostly saw logs. Protection aims are of greater importance.

The dependence of such plans on the general economic policy will form the basis for the creation of conditions suitable for the proper growth of forestry and the woodworking industry within the framework of the whole economic development of the given economic region.

As they develop, the economic regions will become partially self-sufficient as regards their reserves of raw materials. A part of these regions will co-operate in furnishing those materials to their woodworking industries. The development of the production of wood substitutes and the increase in the productivity of the forests and in the percentage of forest land in the regions of formerly low forest density, will also help to raise the productivity of the entire region, and to improve the living conditions of its population.

The delimitation of economic regions and districts makes possible:

1. fixing of economic and production aims for all forest regions, districts and individual forest estates;
2. creation of a forest legislation and administration founded on the most appropriate physical and economic bases.

The method described above, in this form, is intended primarily for countries with a higher degree of economic development who may wish to base their forest policy upon a precise and differentiated basis. The method might equally be suitable for countries that are in the process of establishing the principal objectives of their forest policy. In such cases, this method must be used in a more simplified form.

Internationally Dangerous Tree Diseases

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The maintenance of sustained yields in high quality timber is one of the prime aims of research in forestry. Among the enemies of sustained yields are the following: fire, insects, animals, inroads of "civilization," and diseases. In the disease category one finds not only the pathogenic agents that destroy foliage and kill trees but also those that cause root, butt, and trunk rot. In the United States, the total growth impact of forest diseases is estimated to be about 45 percent of the losses caused by all destructive agents.[1]

In North America, the invasion of foreign forest tree diseases has caused tremendous losses. Examples are chestnut blight, white pine blister rust, and Dutch elm disease. The latter is insect borne. The importance of injurious insects that might come from abroad also is clearly recognized. However, the insects are outside the scope of the present consideration.

Epidemic diseases are much more serious for forest trees than for comparable agricultural crops. If a field of wheat should be destroyed, something else could be planted the next year. But if the trees are damaged, then 10, 25, or 50 years of the productivity of the land may be reduced or lost. Furthermore, with some of the root and butt rot organisms another danger appears. Such pathogens may develop in an apparently innocuous way in the nurseries. Thus, dangerous disease organisms may be distributed with the nursery stock throughout the areas used for reforestation.

A program has been initiated to investigate:

1. what the chances are that certain internationally dangerous diseases might be moved from one country to another;
2. how this movement could be prevented, or at least slowed down;
3. how quarantines could be made more effective;
4. how eradication might be accomplished if a foreign disease should appear;
5. how its damaging effects might be avoided or reduced if it appeared and could not be eradicated;
6. how research might supply badly needed information about the host, the pathogen, and disease development.

[1] United States Department of Agriculture, Forest Service, 1958. *Timber resources for America's future.* Forest Resource Report No. 14, 713 pp. ill.

To facilitate such a program, as a member of the Working Group on Foreign Tree Diseases in Section 24 (Protection) of the International Union of Forest Research Organizations, the author visited 16 different countries to consult with leading foresters, quarantine officials, forest geneticists, and pathologists. His trip was financed by the University of Wisconsin.

Numerous suggestions on what to do have come from many competent people. A summary appears below.

Directory of critical tree diseases

In order to have available information about the epidemic diseases and their importance in each country, an annotated list of them has been or is being prepared in a number of places. From such lists, distribution maps can be made. At the same time, the maps may show the distribution of reporting pathologists rather than that of the disease. So negative reports may be significant only if a qualified person has made a diligent search.

Such lists may not disclose diseases which appear innocuous in one country but which might be dangerous in others (such as the chestnut blight in east Asia). However, research, as discussed later, may bring these to light. An example of such an annotated list is given by Dr. P. Spaulding for the United States (*see* table on the following page).

Much can be learned by a study of surviving exotic trees in plantations already made, as Spaulding has done.

List of key men in each country

A list is being prepared of men active in forest pathology, one or more for each country. These men will exchange critical information, arrange for research on an international basis between suitable individuals, and advise in case of an outbreak.

Strengthening quarantines

Plant quarantines are the accepted bulwark against the entry of dangerous tree diseases. Modern air travel greatly increases the chances for distributing pathogens from one country to another. Many foresters are concerned about the quarantines, no matter how well they are administered, for fear dangerous pathogens may get

American Forest Tree Diseases Potentially Dangerous to Forests of Foreign Countries *

Causal agent	Disease
Virus	Pierce's virus of grape
Cephalosporium diospyri	persimmon wilt
Ceratocystis fagacearum	oak wilt
Ceratocystis fimbriata platani	canker stain
Cercospora thujina	Thuja leaf spot
Clitocybe tabescens	root rot
Coryneum berckmanii	Coryneum blight
Cronartium coleosporioides	western pine stem gall rust
Cronartium comptoniae	sweetgale blister rust
Cronartium harknessii	western globoid stem gall
Diplodia pinea	pine twig blight
Endothia parasitica	chestnut blight
Erwinia amylovora	fire blight
Erwinia nimipressuralis	elm wetwood
Fusicladium saliciperdum	willow scab
Gloeosporium ulmicolum	elm anthracnose
Guignardi aesculi	Aesculus leaf blotch
Gymnosporangium libocedri	Libocedrus-Pomaceae rust
Gymnosporangium nootkatensis	Alaska cedar rust
Melampsora abietis-canadensis	hemlock-poplar rust
Melampsora occidentalis	Douglas-fir-poplar rust
Peridermium coloradense	spruce witches'-broom rust
Phomopsis juniperovora	cedar blight
Phyllosticta minima	maple leaf spot
Phymatotrichum omnivorum	root rot
Rhizoctonia ramicola	silky thread blight
Scirrhia acicola	brown spot needle blight
Sclerotium bataticola	damping-off
Septoria musiva	leaf spot, canker
Trichoscyphella willkommii	larch canker
Thyronectria austro-americana	hardwoods canker
Uncinula flexuosa	powdery mildew
Xanthomonas corylina	filbert blight

* Source: Spaulding, P. 1958. *Diseases of foreign forest trees growing in the United States.* U.S. Dept. Agr. Handbook No. 139, 118 pp. (see pp. 113-118).

through. Forest pathologists have an obligation to supply to quarantine officials a list of the most dangerous pathogens and to describe the diagnostic symptoms by which they may be recognized. At the same time interferences with commerce, travel, and the exchange of scientific materials need to be held to a minimum compatible with protection. With many questions, more research is needed if quarantines are to achieve maximum dependability.

Organizations now operating

Various organizations deal in one way or another with certain aspects of those foreign tree disease problems. The names of some important ones follow: European and Mediterranean Plant Protection Organization; Moscow-Peking Convention; Plant Protection Committee for the Southeast Asia and Pacific Region; Inter-African Phytosanitary Commission; Organismo Internacional Regional de Sanidad Agropecuaria (Central America). FAO in Rome is interested in reducing the spread of forest pathogens from one continent to another and can supply the name and address of the quarantine services in all member countries.

A symposium on critical diseases

The International Union of Forest Research Organizations is planning a symposium on critical forest diseases at its next meeting in Vienna, 10-19 September 1961. Pathologists will select and describe those forest pathogens considered to be of greatest potential importance if they are moved from one continent to another. Publication of the proceedings will provide a useful handbook.

Co-operative international research

For a number of critical problems no one knows the answers. To secure them co-operative research is essential between men in different countries. Obviously, one cannot move either the pathogens or living trees that might carry them from one country to another except with extensive precautions. However, disease-free selected or treated seed can go from one country to a suitable place in another country with relatively little danger.

Some important topics for research follow:

(*a*) *Host ranges.* The different kinds of trees attacked by critical pathogens need exploration. In some cases related ornamentals carry tree diseases. Such research may best be done in nature at a location where the pathogen is active.

(*b*) *Alternate hosts.* Especially with the rusts (e.g., white pine blister rust has one critical stage on currants and gooseberries) the various plants necessary for the development of certain stages of the fungus need to be characterized with precision.

(*c*) *Environmental influences.* Temperature, moisture, light, and mineral nutrition have important influences favoring or discouraging epidemics. The study of microclimate is essential for knowing how the pathogens work and how their damage may be prevented.

(*d*) *Disseminating agents.* The potentialities of different carriers of pathogens need investigation, especially insect vectors.

(*e*) *Seemingly innocuous pathogens.* Attempts should be made to disclose dangerous pathogens that are seemingly unimportant in their native country. Chestnut blight was considered of no consequence

in east Asia. But when the pathogen reached America, it practically eliminated the American chestnuts. Suitable experimental plantings might disclose such wolves in sheep's clothing. (The technique for such research might follow the work with the world collection of wheat.)

(*f*) *Improved methods for eradication.* If a dangerous disease should appear in a limited area of a country, eradication might be tried. Fire and chemicals have been useful, but certain other procedures may be valuable. To be most effective, a technique for eradication should be developed in the country where the disease is active. The results should be available for immediate use to countries where the disease might appear as a new invader.

(*g*) *Disease resistance.* In many countries native trees fail to meet the needs for reforestation or afforestation. Trees from other countries have been widely and advantageously used, but sometimes with disastrous result from disease. Furthermore, tree breeders are continually developing improved trees. In both cases tests for resistance to dangerous diseases are essential. The selection and development of disease-resistant trees hold great promise.

For many kinds of research involving pathogens and isolation, several locations are needed. An island with a mountain might provide many desirable conditions. Changes in moisture occur from the rainy to the dry side. Changes in temperature appear at higher or lower elevations. In some mountain valleys the length of day would be shortened. In such isolated places pathogens might be studied effectively with little danger of spreading the diseases.

Relations with agricultural research stations

In many countries the forest pathologist works in relative isolation from men trained and experienced in handling various field, forage, fruit, fibre, and plantation-crop diseases. Such men usually have a background of information and "know-how" as well as equipment that the forest pathologist could use with advantage. For the most part, all this would be available merely for the asking. Active co-operation between forest pathologists and agricultural pathologists deserves not only encouragement but also the active removal of any physical and administrative barriers that prevent their working together.

In conclusion, the possibilities are dismaying that internationally dangerous tree diseases may move from one country to another and upset sustained yields. However, international understanding, co-operation, and research can do much to slow down or even to prevent more catastrophes like that caused by chestnut blight in America.

Evaluation of Site Fertility

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Many methods have been used for the evaluation of forest site fertility. The most important of these are based on certain characteristics of the stand, on the ground vegetation, on the physical or chemical properties of the soil, or on the nutrient content of the foliage. The disadvantage of the methods based on the characteristics of the stand is that they do not allow the evaluation of a treeless area. Moreover, the treatment of the stand may influence these characteristics. Evaluation based on ground vegetation is almost confined to Finland; elsewhere it has not been found to give a correct picture of site fertility. Since these methods are not wholly satisfactory, great hopes have been entertained of chemical or physical methods of evaluating the fertility of a forest site, either the soil or the foliage being analyzed.

A couple of decades ago soil analysis was much more widely employed than foliar analysis, but in recent years the latter has gained increasing recognition. (Foliar analysis is advocated, for instance, by Tamm 1956, Leyton 1958, Wittich 1958, Wehrmann 1959, and Strebel 1960, soil analysis by Aaltonen 1950, 1951, Viro 1951, 1955, and Wilde 1958). The purpose of the present study is to discuss which of these two methods, soil or foliar analysis, better describes the fertility of forest sites under various soil and climatic conditions.

The study was undertaken with the help of an FAO André Mayer Fellowship and this paper is a short résumé of the final report presented to FAO. The field work in the different countries was made possible by the courtesy of the local forest research organizations.

Material and Methods

Area and samples

This study was restricted to Scots pine (*Pinus silvestris* L.) and Norway spruce (*Picea abies* Link), since these species have quite an extensive distribution and great economic importance in Europe. The material was collected during the autumns of 1958 and 1959. In south Finland, Sweden, Germany, Poland and Austria, 10 pine and 10 spruce stands were studied, in France 10 pine stands, and in north Finland 30 pine stands. These sample plots are not necessarily representative of any country as a whole.

The location of the sample stands is shown for pine in Figure 1 and for spruce in Figure 2. The figures also indicate the natural geographical distribution of Scots pine and Norway spruce in Europe. As far as possible the plots were located in middle-aged stands and on level ground. The Finnish, Swedish, and Austrian stands were on morainic soil, the Polish and French on alluvial soil, and the German stands on both.

As far as possible permanent sample plots belonging to the local forestry organizations were used. In hitherto uninvestigated stands the measurements were carried out by the current methods of the Finnish Forest Research Institute. The dominant height of the stand was measured, and the corresponding height at 60 years of age was determined from the local growth tables or with an increment borer in connection with foliage sampling.

The samples of mineral soil were taken from four pits, surface soil (0 to 30 centimeters) and subsoil (30 to 60 centimeters) being sampled separately, and the samples of corresponding layers combined. In these pits the soil formation type was also determined and the horizons measured. The humus layer was sampled with a cylinder at 20 points on the diagonals of the plot. The content of stones was measured by the rod-testing method.

Needle samples were taken from five dominant trees at the highest level that could be reached by climbing, usually two to three meters from the top. The samples were taken from the south side and from unshaded branches. Current and two-year needles were sampled separately.

Laboratory work

All laboratory work was done at the soils laboratory of the Finnish Forest Research Institute, by the usual methods employed in this laboratory. The following analyses were carried out:

1. *Mineral soil:* bulk specific gravity, mechanical composition, exchangeable nutrients (NH_4-acetate), total nitrogen, humus content, basic mineral index (Tamm), water-holding capacity (Bouyoucos), and acidity in water and KCl.
2. *Humus layer:* exchangeable and total nutrients, total nitrogen, acidity, and CO_2 evolution.
3. *Needles:* total nutrients.

As usual, the soil analyses were made with the fine soil (> 2 millimeters). To ensure that the results of

FIGURE 1. – *Location of pine stands.*

FIGURE 2. – *Location of spruce stands.*

different countries were mutually comparable, the amount of nutrients per hectare was calculated and these figures were used in all discussions.

Site index

Several characteristics of the stand, such as height, diameter, basal area and volume, have been used as indicators of site quality. In this study the *site fertility* is given by the average height at 60 years of age of the 100 thickest trees per hectare. It is here called the *site index*. Of the characteristics of the stand men tioned above, the dominant height is the least dependent on the treatment of the stand, provided that there has been no crown thinning.

The stands of the same species of tree in a country form a unit in the first discussion of the results. The stands of a unit were divided into two groups according

to the site index. The five stands with the highest site indices form group I, the five with the smallest values group II. The average site index was equally high on brown soil and brown podsolic soil and these plots were combined in the discussion. The average site indices and ranges of variation were:

	Average	*Range*
	..... *Meters*	
Pine, podsol soil	17.7	10-25
Pine, brown soil	24.8	20-28
Spruce, podsol soil	23.4	18-29
Spruce, brown soil	25.0	21-30

Results of the study

Results of soil analyses

It is impossible to present here the whole of the data obtained during the study. However, to provide the reader with some idea of the nutrient status, the average amounts of exchangeable nutrients, total nitrogen and organic carbon in the surface soil layer are given in Table 1. This Table shows very clearly that the level of nutrients varies greatly in different countries and different soil types. Almost without exception the quantities in a country were largest in the brown soils and smallest in the podsol soils. In the pine stands the most conspicuous features were the small amounts of calcium in the French soils and of magnesium in the Polish podsol soils, and the great amounts of phosphorus in the Polish soils. The nutrient levels of the Finnish and Swedish soils were surprisingly similar. In the spruce stands the most conspicuous features were the large amounts of lactate-soluble phosphorus in the Polish soils. These data do not allow a general comparison of pine and spruce stand soils but the nutritional status seems to vary greatly in different circumstances.

The distribution of the nutrients in the profile analyzed varied for different nutrients and soils. In the brown soils 50 percent or more of these nutrients were usually contained in the subsoil, in the brown podsolic soils this figure was somewhat lower and in podsol soils about 30 percent. A fact that is often overlooked is that usually only a small fraction of the organic material and nitrogen is present in the raw humus layer. Here the bulk of these elements was found to be in the surface soil, and even in the podsol soils the subsoil contained much more nitrogen and often organic matter, too, than the humus layer.

Table 1. – Average Quantities of Acetate-soluble Nutrients in Mineral Soil Layer (0 to 30 centimeters)

Country	Soil type[1]	No.	MnO	MgO	CaO	K_2O	P_2O_5	N. tot.	Org. C	C/N
			..... *Kilograms per hectare*					.. *Tons per hectare* ..		
	Pine stands									
France	P	4	44.3	42.5	52	139	16.6	2.79	61.7	22.4
”	B	6	204.0	303.0	757	229	36.4	3.51	42.1	12.1
Germany	P	6	35.7	66.2	420	155	39.3	3.42	66.6	19.8
”	BP	3	156.0	256.0	3 250	187	51.5	4.58	71.4	16.1
”	B	1	229.0	2 930.0	28 600	617	16.5	11.25	110.0	9.8
Austria	P	10	14.1	19.1	160	115	73.5	1.97	39.9	20.4
Poland	P	6	61.2	1.0	150	85	147.0	2.24	28.0	12.6
”	BP	4	95.7	37.3	479	116	164.0	3.41	39.3	11.5
Sweden	P	10	70.4	21.6	204	64	44.7	1.59	28.0	17.5
S. Finland	P	10	71.5	24.1	309	69	47.1	1.63	32.1	20.3
N. Finland	P	30	36.3	37.5	139	86	30.0	1.41	18.4	13.5
	Spruce stands									
Germany	Sg	3	115	43.7	95	184	92.0	5.66	78.9	13.9
”	BP	6	157	34.5	142	116	47.7	3.57	54.2	15.8
”	B	1	190	84.0	1 000	147	50.0	2.47	39.6	9.3
Austria	B	10	202	406.0	4 280	307	65.9	6.78	77.5	11.4
Poland	P	3	145	79.9	1 080	124	67.8	3.01	41.1	13.7
”	BP	7	153	111.0	1 300	131	89.3	3.71	46.9	12.9
Sweden	P	5	42	5.6	67	69	18.9	2.68	54.1	20.3
”	BP	5	131	35.4	233	115	44.6	3.92	57.1	14.9
S. Finland	P	10	130	88.3	761	127	47.6	4.33	68.1	16.0

[1] P = podsol. BP = brown podsolic. B = brown. Sg = stagnogley.

The C/N ratio was highest in the raw humus layer and lowest in the subsoil. In corresponding layers the ratio was usually highest in the podsol soils and lowest in the brown soils. The corresponding figures in the different countries did not usually vary to any great extent except for the Polish figures, which were exceptionally low, especially in podsol soils. The ratio for north Finnish soils was also very low. In the humus layer the ratio was higher in the spruce stand soils, in the mineral soils usually in the pine stand soils.

Soil nutrients and site fertility

The fertility of a site is determined by the climate and the soil. Since the other main factor affecting fertility, the climate, varies greatly within the research area, the sample plots in a country were selected within as small an area as possible, so that the climatic variations in a unit would be negligible. The local correlation between the site index and the properties of the soil was first examined graphically. After this the mean quantities of nutrients for the site index groups described earlier were calculated and the significance of the difference of means in a country was studied against the null hypothesis with the t-test. In more extensive areas the correlation was also studied by statistical analysis. Pine and spruce stands are discussed separately.

Examination of the pine stands. A significant difference in the quantities of nutrients between the index groups was most frequent with regard to nitrogen and manganese. As for the other nutrients, it was only in the amounts of phosphorus that a significant difference was encountered in two countries. As in earlier studies, a significant correlation was found between the fertility of pine stands and the amounts of calcium and magnesium in south Finland.

The site fertility showed less frequent correlation with the physical characteristics of the soil than with the chemical characteristics. In the French, Polish and north Finnish stands there was a correlation between the site fertility and the content of fine soil, in the south Finnish and German stands between the fertility and the basic mineral index. Correlation between the fertility and the water-holding capacity was found in the north Finnish stands only.

Examination of the spruce stands. No significant difference in the amounts of a nutrient was ever found in two countries. The most conspicuous feature is the highly significant negative correlation between site fertility and certain nutrients in Austria. This indicates that these nutrients are present in supraoptimal amounts in these calcareous soils. In south Finland a significant correlation between the site fertility and the amounts of calcium and magnesium was also demonstrable in spruce stands.

There was no correlation between any physical soil characteristic and the fertility of spruce stands.

The acidity of the soil and the total nutrients of the raw humus layer proved to be poor indicators of soil fertility in both pine and spruce stands.

The sample plots were intentionally chosen from different soil formation types. It is quite possible that this is a reason for some of the above results. It is to be regretted that more stands could not be studied in each country.

Needle analysis and site fertility

The average nutrient contents of needles are presented in Table 2. The contents were almost equal on brown and brown podsolic soils and they are presented combined. There was a tendency for the average content of most nutrients to be lower on podsol soils. The content varied considerably in different countries but this variation was rather irregular. The variations in the contents of current and two-year needles were in general similar. The nutrient content was calculated on both dry matter and ash. The latter figures did not provide any additional information for present purposes.

Table 2. – Average Nutrient Content of Needles

Soil type	Ash	P_2O_5	MnO	MgO	CaO	K_2O	N
	Percentage of dry matter						
Pine							
Current needles							
Podsol	2.495	0.369	0.073	0.150	0.325	0.849	1.30
Brown	2.554	0.387	0.140	0.193	0.389	0.793	1.58
Two-year needles							
Podsol	2.723	0.286	0.126	0.130	0.577	0.661	1.27
Brown	3.036	0.344	0.080	0.171	0.650	0.686	1.59
Spruce							
Current needles							
Podsol	3.361	0.481	0.100	0.197	0.539	0.889	1.33
Brown	3.195	0.378	0.180	0.185	0.597	0.823	1.29
Two-year needles							
Podsol	3.833	0.403	0.147	0.192	0.828	0.756	1.21
Brown	4.172	0.298	0.250	0.173	0.913	0.728	1.24

The nutrient content of the needles varied much less than the quantity of nutrients of the soil. The former varied almost independently of the latter. Only for nitrogen was a highly significant (0.1 percent level) correlation found between the nitrogen content of the pine needles and the amount of nitrogen in the surface soil.

The correlation between the site fertility and the nutrient content of the needles was in general not

significant. In pine stands a significant correlation is found in two countries only for the nitrogen and phosphorus of the current needles and the nitrogen and manganese of the two-year needles. In spruce stands a significant correlation occurred much less frequently than in pine stands and was never encountered for any nutrient in more than one country.

Discussion

Effect of climatic factors

These studies did not reveal any distinct effect of climate on the nutrient status of the soil as a whole. The amounts of organic matter and nitrogen, however, were largest in central European soils, smaller in southern Scandinavia and smallest in north Finland. The effect of climate on the nutrient content of the needles proved to be very slight.

A significant correlation between the site fertility and the nutrient level was usually only found when all the stands of a unit were on the same soil type. Therefore, an examination was made of the possibility of combining stands of adjacent countries in the consideration of the results. It proved that in central European pine stands on podsol soil there was a highly significant correlation between the site index and the quantity of nitrogen in the surface soil. In brown and brown podsolic soils the correlation depended on the calcium level of the soil. When soils rich in calcium were excluded (maximum CaO included 1,700 kilograms, minimum excluded 5,200 kilograms per hectare) a highly significant correlation was found between the site index and the quantity of nitrogen of the surface soil both in pine and spruce stands. (On podsol soil there were three spruce stands only.) There was no significant correlation between the site index and the other nutrients in this extensive area.

The nutrient content of the needles showed some correlation with site fertility in the more extensive area. However, as is shown, the nitrogen content of the needles follows the nitrogen level of the soil and so this correlation is only apparent.

These stands are fairly representative of the natural range of pine and spruce in central Europe. The above correlations indicate that the climate throughout this area is equally favorable for the growth of these conifers. The climates of the Finnish and Swedish research areas seem to differ so much in this respect from one another and from the central European climate that these areas must be discussed separately.

Evaluation of site fertility

The material of this study is not sufficient to allow final conclusions as to which of the methods, soil or foliar analysis, better describes site fertility. However, the results clearly indicate that, in spite of the limitations to be pointed out in this paper, soil analysis gives more reliable results. When the differences between the index groups were examined, it was noticed that a significant difference was much more often found in the amounts of nutrients in the soil than in the nutrient contents of the needles. In particular, the amounts of nitrogen, manganese and phosphorus proved to be important local indicators of site fertility. In addition, the correlation found in central European stands between the site index and the nitrogen level of the soil shows more definitely the superiority of soil analysis for the evaluation of site fertility.

The present results indicate that nitrogen best describes the soil fertility. This study does not settle the mutual order of importance of the other nutrients. This order is probably different in different circumstances, e.g., on different soil formation types. Thus, in a scientific investigation as many nutrients must be analyzed as possible. When the local conditions are adequately known, an analysis of a few nutrients may suffice for the evaluation of forest site fertility.

These studies indicate that manganese frequently shows a strong correlation with site fertility. We assume at present that plants only need manganese in very minute amounts, but trees may have some unknown needs. It is evident that much more attention must be paid to the role of manganese, and perhaps of many other nutrients, too, in tree growth.

When the data for central European pine and spruce stands on the same soil type were combined, the correlation coefficient between the site index and the quantity of nitrogen was of equal significance (0.1 percent level) to that for one species of tree only. This would indicate that these species have similar growth at similar nitrogen levels of the soil in this area.

It was estimated that only one sixth to one half of the rotating nutrients of the soil are exchangeable. On the other hand, nitrogen is totally determined by Kjeldahl analysis. There are indications that plants may be able to use nonexchangeable nutrients and, through contact feeding, even mineral particles of the soil. This may be one of the reasons why nitrogen analysis here most universally reflected the soil fertility.

Many scientists consider that needle analysis gives more reliable results in the evaluation of site fertility. However, this method has mainly been used in young stands or plantations and the present study deals with mature stands. The greatest value of needle analysis is perhaps in revealing the deficiency of certain nutrients. It seems evident that in the stands studied here the nutrient content of the needles has usually been above the limit of deficiency, with the possible exception of the nitrogen content of the Scandinavian pine stands. The needles never showed chlorosis.

The citric acid cycle of metabolism contains several organic acids and certain plants contain other acids too, for instance oxalic acid. It is apparent that the function of the cations of cells is in large measure to balance the organic acids and inorganic anions such as phosphate,

sulphate and chloride (e.g., DeKock 1958). For this reason it is hardly to be expected that analysis of foliar cations would satisfactorily reflect site fertility.

Soil analysis

The correlation between the site index and the nutrient quantity was calculated not only for the surface soil but also for the subsoil and for the total layer analyzed. It proved that the correlation coefficient was generally most significant for the surface soil. These results confirm the earlier observation that it is most important to know the nutrient level of the upper mineral soil. The exact depth of the soil layer that should be analyzed probably varies in different countries, but ocular observations in connection with the field work indicate that the depth of the roots of either species of tree usually varies within quite narrow limits. Thus, the depth of the surface soil layer to be analyzed for the evaluation of site fertility could probably be agreed universally without much risk.

For soils with a water-holding layer or ground water at a depth that the roots can reach, an exception to the usual procedure is required. These soils must be studied in some cases to a depth of several meters. The investigator must be prepared for this in all alluvial soils.

In studies on soil fertility the exchangeable nutrients are commonly determined. The amount exchanged depends on several factors and one of the least studied of these despite its probable importance is the function of vegetation, and of organic matter in general. It is known that many organic acids make chelates, complexes or precipitates with polyvalent cations and prevent the exchange of these cations.

Random analyses indicate that these "inhibitory compounds" are present in much greater amounts in spruce litter than in pine litter. Perhaps this partly explains why the correlation between the site fertility and the mineral nutrients of the soil was poorer in spruce stands. As an example of the amounts of an inhibitory compound it may be mentioned that a spruce litter sample recently analyzed in our laboratory contained about 50 mille equivalents per 100 grams of oxalic acid. Calcium oxalate is sparingly soluble and this calcium cannot be extracted with ammonium acetate. The soils of the present study also varied greatly in the percentage exchangeability of the nutrients of the humus layer. For these reasons more fundamental work needs to be done on the chemical methods of soil analysis. This work must be done on forest soil samples and not on agricultural soil, as hitherto.

Phosphorus was determined in this study by two methods, extraction with ammonium acetate and with calcium lactate. The amounts extracted were usually smaller with lactate than with acetate. However, in all the Polish soils, but especially in the pine stand soils, the amounts extracted with lactate were much larger. A significant difference between the index groups was usually detected simultaneously with both methods.

A negative correlation between site fertility and the basic mineral index was found in the pine stands of north Finland. Some of these sample plots were on a soil derived from granulite, and the heavy minerals of granulite (specific gravity > 2.68) are almost worthless as a source of plant nutrients. Thus, the applicability of this method in fertility studies must be confirmed by mineralogical analyses.

A highly significant (0.1 percent level) correlation was found between the water-holding capacity and the content of fine soil (< 0.02 and < 0.002 millimeter). Thus, this simple method serves very well as a rapid measure of soil texture.

Conclusions

Both soil and foliar analyses are widely used as means of evaluation of site fertility. Therefore we must try to determine the conditions in which one of these methods has more advantages and fewer shortcomings than the other.

It was mentioned earlier that foliar analysis may reveal deficiency of a nutrient. It might also have advantages on slopes where the moving soil waters continuously bring new nutrients. On stratified soils, too, foliar analysis may, perhaps, have advantages. However, the foliar sampling season is very short. Moreover, the results are greatly dependent on the weather before sampling, for instance on the rainfall, and a stand must be sampled over several years (Wehrmann 1959). The results may also depend on metabolic disturbances (DeKock 1958). And finally, foliar analysis does not allow evaluation of the fertility of a treeless area.

Soil analysis, on the other hand, probably gives more reliable results in mature and young stands, and will do so all the more when the nutrient requirements of trees in different soil conditions are better understood. In sapling stands and plantations the two methods may be of equal value. However, it is evident that the results of foliar analysis are more difficult to interpret than those of soil analysis (Wilde 1958).

The final conclusion to be drawn from these studies is that, of these two methods, soil analysis should be the standard method in the critical evaluation of forest site fertility. When the defects of soil analysis are overcome, it will tend to supplant foliar analysis. In exceptional cases, soil analysis may, perhaps, be supplemented by foliar analysis.

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WORLD SOIL MAP

A major step toward a soil map of the world was taken in June 1961, when an advisory group met in Rome to approve the timetable for a joint FAO/UNESCO undertaking which will extend over a four-year period.

This first soil map of the world should provide a realistic picture of the distribution of major soils and, by co-ordinating national and international effort, will allow the exchange of knowledge between one region and another. It will enable conclusions to be drawn as to how different soil areas can be used. The small-scale world map will derive from larger-scale regional maps, such as the European soil map, and will also lead to larger-scale regional versions and eventually to soil resources maps which will interpret soil properties in terms of agricultural production potential.

Co-ordinated by FAO's Land and Water Development Division, the first phase of the work will be the preparation of regional maps bearing an integrated legend: Australia in 1962; North America, South and Central America, Europe and the Near East in 1963; north and central Asia (which together with Europe contains the area of U.S.S.R.), south and southeast Asia, and Africa in 1964. In this way a series of continental maps and a first look at the world soil map will be available for the next Congress of the International Society of Soil Science to be held in Romania in 1964. The second phase will be the preparation of a second draft of the world map in 1966, with a view to final publication in 1968 in the form of a loose-leaf atlas comprising some 40 sheets.

World Forestry

Belgium

A set of eight values was issued to mark the independence of the former Belgian Congo.

Finland

A stamp issued to celebrate the centenary of the State Board of Forestry. This is the third forestry set issued by this country.

Indonesia

A set of four stamps was issued to commemorate the 15th Anniversary of the Republic.

Iraq

The first time that Iraq has publicly proclaimed interest in Arbor Day by issue of a "forestry" stamp.

Lebanon

Two airmail stamps were issued to commemorate the 25th anniversary of the Friends of the Tree Society.

Liechtenstein

For the third year this small principality issued a set of three stamps depicting trees and bushes. The 20-rappen value shows larches.

Ryukyu Islands

For the third time this country issued stamps to celebrate Tree Week.

Sudan

A set of three stamps was issued to commemorate the Fifth World Forestry Congress.

in Stamps

Sweden

Issued to celebrate the centenary of the Forest Administration.

Tunisia

A set of four stamps was issued to commemorate the Fifth World Forestry Congress.

Taiwan

A set of three stamps was issued on the occasion of the Fifth World Forestry Congress.

Union of Soviet Socialist Republics

A 40 kopek stamp issued to celebrate the centenary of the artist I.L. Levitan, shows a reproduction of his famous painting "March," a forest scene. This stamp was also used to publicize the U.S.S.R.'s forests.

United Arab Republic Syria

Arbor Day stamp.

United States of America

Two more stamps in the series of commemorative stamps honoring conservation — soil conservation and range conservation. The latter stamp was first issued in February 1961 on the occasion of the annual meeting of the American Society of Range Management.

Commodity Report

Sawn Softwood

In 1959 world production of sawn softwood totaled 54.04 million standards, exceeding by 2.89 million standards the previous postwar peak recorded in 1955. Between the latter year and 1958 the line of upward progression, constant since the war, dipped to a point just below 50 million standards. The check appeared first in 1956 in the United States and reflected almost exactly the recession observed throughout that country's economy in the same period. In Europe the downward movement came some months later and though of short duration, proved sufficiently severe to unsettle the price structure in 1958. Some curtailment of Europe's production occurred between 1957 and 1959 but the statistical changes were not marked. Of necessity, producers in northern Europe must plan operations far in advance, and the level of production rarely corresponds to the market situation at a given moment. In the period under review some overproduction was evident in the 1957 to 1958 season but as industry and building revived strongly toward the end of 1958, surplus stock became a valuable "cushion," because at that juncture production was being reduced.

World export trade in sawn softwood exhibited only slight fluctuations between 1957 and 1959. In 1957 the total of 6.5 million standards showed a slight improvement over the 1956 export; in 1958 there was a negligible decline, and in the following year exports again turned upward to reach the level of 6.9 million standards. Incomplete data for 1960 indicate that the upward trend in export trade has continued and has at its foundation a considerable enlargement of sawn softwood production.

Undoubtedly the most impressive development of the past three years has been the rapid expansion of sawmill production in the U.S.S.R. Since 1957 the U.S.S.R. has occupied the leading position among the world's producers and although in 1959 production in the United States increased by more than a million standards, the U.S.S.R. remained the largest producer by a clear margin of over three million standards.

The past three years have also been notable for the re-emergence of Canada as an effective competitor in markets outside the North American continent. At the beginning of the period, the postrecession building boom in the United States, coinciding as it did with flagging demand and low prices in Europe, brought heavy reductions in Canadian overseas shipments in 1958 and 1959. In 1960, however, development took an almost exactly opposite course; falling demand in the United States led directly to stock accumulation and lower Canadian prices at a moment when European softwood prices showed renewed buoyancy in response to vigorous buying by the principal importing countries. In 1960 Canada succeeded in doubling her exports to Europe. Among the other regions few changes indicative of new trends are apparent and it would seem that economic development in timber-deficient areas of Asia and the Near East is proceeding at a tempo bearing little relationship to the rate at which resources of coniferous timber are being exploited or import trade in softwood extended. It seems certain, therefore, that industrial development is being sustained by recourse to mineral deposits and man-made materials.

In the following review the more important features of production and trade are discussed region by region.

North America

In 1957 and 1958 cyclical recession affected important sectors of the United States economy, bringing with it a sharp contraction in the production of sawn softwood. At its low point, in 1958, output fell to 13.7 million standards (Table 1), compared with 15.2 million and 16 million attained respectively in 1956 and 1955. Although the general industrial index failed to register an appreciable gain until later in the year, 1958 saw the beginning of a new boom in residential building, induced by low interest rates and reinforced by generous

Table 1. – United States: Sawn Softwood Market
(in millions of standards)

	1957	1958	1959	Jan.	June	Percentage change from 1959
Production	13.85	13.70	14.80	14.42	—	– 2.5
Gross stocks (end of period)	2.96	2.83	2.91	—	3.22	+23
Imports	1.38	1.60	1.90	—	—	—
Exports	0.31	0.27	0.31	—	-	- -

finance made available by the Federal Housing Authority under the terms of the Housing Act of 1958. In April 1958 the Federal Reserve Bank of New York discount rate stood at 1.75 percent and remained at that level until November.

While industry at large made tardy use of "cheap money," the housing market responded eagerly and by the spring of 1959 housing starts were approaching the high point recorded in 1950. Softwood consumption, in which demand from the building industry bulks so large, showed significant improvement over the greater part of 1958 and in turn contributed to intensified effort in the sawmilling industry. From 1958 to 1959 sawn softwood production rose by over a million standards, and imports, mainly from Canada, increased from 1.6 million to 1.9 million standards. As expansionist trends appeared in other sectors of the country's economy during the closing months of 1958 and the early part of 1959, interest rates rose sufficiently to act as a brake on further development in the housing field. However, demand for sawn softwood remained active up to the fourth quarter of 1959, when signs of stock accumulation at the mills became very noticeable. Consumption in the first half of 1960 underwent drastic curtailment, for although production had not risen to any great extent compared with achievement in 1959, midyear stocks were no less than 23 percent higher than at the same date in the previous year. Toward the end of 1960 the United States administration displayed fresh initiative in the sphere of housing finance which is calculated to revitalize construction during 1961.

For some years the flow of Canadian timber into the United States market has fluctuated in sensitive correlation with the requirements of the U.S. building and constructing industries. As considerably more than one half of Canada's sawn softwood export to the United States is drawn from the mills of British Columbia, the Province which also provides the preponderant share of Canada's overseas exports, the state of demand in the United States exercises an important influence on Canadian policy and export prices. Canadian softwood production exhibited marked stability between 1957 and 1959 and in the same period, exports to the United States increased steadily from 1.4 million to 1.8 million standards (Table 2). In the same period, which coincided with a fall in the general level of European softwood prices, Canadian exports to Europe declined by 30 percent. In the final quarter of 1959 and in the early months of 1960 the Canadian exporters who had made plans for continued expansion of production were compelled to recognize a cutback in orders for the United States, amounting by the end of 1960 to a 0.6 percent reduction of the volume delivered to that market in 1959. Fortunately this loss was heavily outweighed by greatly increased shipments to Europe, and especially to the United Kingdom. The changed pattern of trade is clearly revealed by Table 2. Notwithstanding an over-all increase of 10 percent in Canadian exports in 1960, the build-up of unsold stocks was appreciable and energetic measures were taken to regulate production and reduce inventories. Owing to the abrupt check in United States building activity during the second half of 1959 and a subsequent falling away of demand in Canada, sawn softwood stocks in North America as a whole reached a height not witnessed in recent years.

Table 2. – Canada: Sawn Softwood Market
(in millions of standards)

	1957	1958	1959	1960	Percentage change from 1959
Production	3.52	3.46	3.46	3.69	+ 6.6
Total exports	1.88	2.03	2.13	2.34	+ 9.9
of which to:					
United States	1.40	1.62	1.80	1.79	– 0.6
Europe	0.26	0.23	0.18	0.36	+ 100
Stocks (end of period)	0.56	0.52	0.54	0.64	+ 19

Europe

In the period under review, import-export trade, in volume and pattern broadly indicative of industrial trends within the European economy, has displayed somewhat greater fluctuations than the rate of production in the principal countries possessing exportable surpluses. From the high levels of 11.3 million standards in 1955 and 10.9 million in 1956, European production of sawn softwood (outside the U.S.S.R.) dropped back to an average of just over 10.6 million standards for the years 1957, 1958 and did not rise again until 1960 when, it is provisionally estimated, output regained 1955 volume. Over the period from 1954 to 1958, European imports from all sources rose and fell by amounts varying between 250,000 standards and 500,000 standards, while exports from European countries followed the same course, although the quantitative fluctuations were smaller. From 1958 onward, however, both imports and exports showed a consistent upward tendency and in 1960 trade reached proportions comparable with those recorded before the war.

Consumption of sawn softwood has maintained close correspondence with industrial development and the requirements of the housing program in Europe. After a brisk revival in 1957, trade during the following year was hampered by the onset of partial economic recession in western Europe, which in turn imposed restrictions on both industrial and residential building. Economic stagnation, however, was of short duration and in 1959 western European countries joined their eastern neighbors in a new and spectacular advance all along the industrial front. Economic recovery gained momentum throughout the year and although inflationary tendencies, combined with acute labor shortages in some countries of western Europe, necessitated governmental intervention and some damping down of initiative in the interests of stability and orderly progress, expansion of gross national product continued at a slightly higher rate in 1960.

The increasing scale of housebuilding in western and eastern Europe, supplemented by new factory construction and the growth of export trade, gave powerful impetus to sales of sawn softwood in the spring and summer of 1959 and stimulated an almost unprecedented volume of forward buying in the autumn. In 1959, housebuilding in the U.S.S.R. was 13 percent higher than in 1958 and 39 percent above the 1957 level; in Western Germany house completions were 28 percent higher in 1959 than in the previous year.

Although the log cut in Sweden and Finland was reduced in the 1958/59 felling season and the resultant production of sawn timber in 1959 showed a drop of almost 5 percent by comparison with the 1958 total, the year's much heavier consumption needs were met by depleting the substantial stocks which had accumulated when requirements, owing to the 1958 recession, failed to absorb the relatively high volume of timber production in the 1957/58 season. This point is illustrated in Table 3, from which it will be seen that Sweden succeeded in raising her sawn softwood exports from 875,000 standards in 1958 to 1.02 million standards in 1959, despite a decline in production amounting to over 200,000 standards, while Finland, with only a modest increase in mill output, was able to push up exports from 758,000 standards in 1958 to 950,000 standards the following year. Toward the end of 1959, increased exports from the U.S.S.R. made a valuable contribution to supplies. On a smaller scale, increased availabilities from the mills in Austria and Western Germany, which were able to adjust production flexibly to changes in demand, played a useful subsidiary role in satisfying the requirements of the building industry.

While current needs were covered in every instance, most of the importing countries in Europe held lower stocks at the end of 1959 than in any year since 1954. In the United Kingdom, for instance, where consumption over the whole year was 11 percent higher than in 1958, stocks at the end of 1959 amounted to no more than 472,000 standards.

On the well-founded assumption that demand in 1960 would at least retain its 1959 strength and would impose a heavy drain on stocks during the early months of the year, importers started their forward buying campaign much earlier than usual. By Christmas 1959, contracts with the U.S.S.R. and both Sweden and Finland had reached the highest level in recent years, the scale of forward purchases standing in sharp contrast with the paucity of short-term supplies. Fortunately, deliveries from southern Sweden, Poland, Czechoslovakia and Austria during the winter and early spring went some way toward alleviating the consumers' difficulties.

In planning production for the 1959/60 felling season, producers in northern Europe had proceeded with much greater boldness than would have seemed prudent a year earlier. Low stocks, firm prices and buoyant demand counseled increased production and it is estimated that Swedish fellings increased as much as 25 percent over the previous year's achievement, reaching a total of between 45 and 47 million cubic

TABLE 3. – SAWN SOFTWOOD MARKET IN EUROPE [a]
(in thousands of standards)

	1957	1958	1959	1960	Percentage change from 1959
Total production	*10 765*	*10 740*	*10 530*	**11 000*	
of which:					
Austria	940	971	978	1 019	+ 4
Finland	877	1 000	1 070	—	
France	1 085	1 085	1 049	—	
Germany, W.	1 197	1 177	1 205	—	
Germany, E.	563	564	548	—	
Poland	1 366	1 313	1 283	1 233	– 4
Sweden	1 650	1 680	1 475	—	
Total imports	*3 815*	*3 570*	*3 980*	—	
of which:					
Germany, W.	600	629	678	784	+ 16
Italy	390	389	431	—	
Netherlands	422	337	422	481	+ 14
United Kingdom	1 457	1 296	1 465	1 820	+ 24
Total exports	*3 160*	*2 920*	*3 230*	—	
of which:					
Austria	697	661	688	718	+ 4
Finland	704	758	950	—	
Sweden	1 099	875	1 024	1 097	+ 7

[a] Excluding U.S.S.R.
* Estimated.

meters, while Finnish fellings are reported to have exceeded the peak postwar 1955 total of 43.3 million cubic meters (r). In Europe as a whole (excluding the U.S.S.R.) production almost reached the level of 5.5 million standards, and when the full year's figures are available, they will no doubt show that 1960 production matched or even surpassed the high 1955 total.

Statistics disclosing the complete picture of European consumption are still awaited but data already to hand indicate that the strength of demand was appreciably greater in 1960 than in either of the two preceding years. In this connection it is noteworthy than in the United Kingdom, the leading importing country in Europe, apparent consumption in 1960 rose to 1.64 million standards (6 percent more than the 1959 figure), the highest point reached in any year since the war. Increased utilization, stimulated by a marked rise in industrial and building requirements, was also in evidence in Western Germany as well as in the timber exporting countries. In several countries, however, the pressure of demand was mitigated by technical developments designed to save timber. Without exception, all the leading softwood exporting countries handled a greater volume of business during the year now past, and at the Eighteenth Session of the Timber Committee of the Economic Commission for Europe, held in Geneva last October, the previous year's forecast of 1960 exports

was raised by 20 percent in the light of actual demand manifest during the year.

A study of Table 4, which records the movement of sawn softwood between the countries of eastern and western Europe, suggests that eastern Europe is becoming less and less dependent on imports from the west and is now, therefore, receiving bigger supplies from the U.S.S.R. The trend is of considerable interest because, up to 1957, imports from western Europe had been mounting year by year. Between 1957 and 1959, exports from eastern European countries to the west, on the other hand, showed little change.

TABLE 4. – SAWN SOFTWOOD TRADE BETWEEN COUNTRIES OF EASTERN [a] AND WESTERN EUROPE [b]
(in thousands of standards)

	1956	1957	1958	1959
Exports by eastern European countries to the West	170	235	252	250
Imports by eastern European countries from the West	77	67	40	41

[a] Czechoslovakia, Bulgaria, Eastern Germany, Hungary, Poland, and Romania.
[b] Figures taken from countries of western Europe.

Production in the U.S.S.R., as presented in Table 5, has undergone remarkable expansion, registering an increase of 4.25 million standards between 1955 and 1959. At 18 million standards, the country's output was the largest in the world. Although total Soviet exports, including 606,000 standards to western Europe, represented (at 937,300 standards) only 5 percent of production in 1959, the U.S.S.R. has greatly strengthened her influence on the European timber market. Shipments to western Europe in 1959 were more than

TABLE 5. – SOVIET UNION: PRODUCTION AND TRADE OF SAWN SOFTWOOD
(in thousands of standards)

	1955	1956	1957	1958	1959
Production *	13 750	13 930	14 915	17 100	18 010
Exports to western Europe only	[a] 393	[a] 370	[a] 461	485	606
Imports from western Europe only	[a] 53	[a] 51	[a] 53	[a] 41	[a] 26

* Estimated.
[a] Figures taken from countries of western Europe.

double the 1954 total and it is now clear that still larger deliveries were made in 1960. It may well be that Soviet exports to all countries are approaching the level of trade in the years immediately before the second world war, but it should be remembered that the U.S.S.R.'s share of export markets was considerably higher in the early thirties and in the period 1933-36 averaged 1.4 million standards per annum.

Latin America

Although Latin America is pre-eminently a region of deciduous forests, coniferous species have accounted for between 50 and 60 percent of total sawn timber production for some years past. This phenomenon is explained by two factors: firstly, the relative improvement in the stocking of marketable species in the coniferous forests, which facilitates commercial exploitation, and secondly, the strongly developed demand for softwood in both regional and overseas markets. Indeed, over 90 percent of the region's timber trade is in sawn softwood.

Production is largely concentrated in Brazil, Chile and in the Central American and Caribbean countries. Brazil alone contributes about 70 percent of the region's total production (Table 6), while Mexico and the Central American countries provide 28 percent. In many parts of the region, however, the coniferous forests have been severely overcut during the past decade. Resources in Brazil, in particular, have been affected by both excessive fellings and the progress of coffee cultivation, while in Honduras uncontrolled exploitation has depleted the forests of the Atlantic coast. On the credit side of the picture, Chile's vast plantations of pine will in the near future yield considerable quantities of log size timber. In Mexico, production of sawn softwood has declined over the past ten years but sound forest management, coupled with improved sawmilling practice, holds promise, so that in due course timber production will be stabilized and perhaps increased.

TABLE 6. – LATIN AMERICA: SAWN SOFTWOOD PRODUCTION AND TRADE
(in thousands of standards)

	1955	1956	1957	1958	1959
*Total production **	*1 130*	*1 140*	*1 020*	*1 200*	*1 250*
of which:					
Brazil	794	756	696	750	—
Mexico	163	185	—	218	—
Honduras *	50	28	44	63	111
Chile	27	44	34	—	63
*Total exports **	*340*	*220*	*370*	*320*	*255*
of which:					
Brazil	238	134	290	239	171
Honduras	40	33	44	35	43
Chile	20	20	6	11	11
*Total imports **	*355*	*280*	*370*	*315*	*240*
of which:					
Argentina	179	* 123	* 203	192	107
Uruguay	29	20	22	—	14
Venezuela	25	30	46	24	34
Mexico *	21	5	5	4	—
Peru	14	15	17	9	9

* Estimated.

Considered as a whole, Latin America's exports and imports roughly balance, averaging about 310,000 standards on either side of the account. The principal exporting country is Brazil, which traditionally sends the bulk of its exports into Argentina, and the remainder chiefly to Europe and Uruguay. On a modest scale Chile has developed a market for its pine exports in Argentina and is now opening up sales in Peru and Uruguay. During the Korean boom, Chilean exporters placed substantial quantities of sawn softwood in the Argentinian market but, at the time, shipments lacked uniformity and the trade suffered a temporary setback. Today, however, producers in Chile are trying hard to modernize their mills and improve the quality of output with the aim of making Chile one of the major sources of supplies for the Argentinian market. Mexican exports go mainly to the United States, and as trade has grown up on the basis of careful attention to buyers' requirements, it is subject to little fluctuation. The Central American countries, notably Honduras and Nicaragua, market most of their sawn goods output in Cuba, Venezuela and Colombia, while minor quantities of special dimensions and qualities (Honduras pitch pine) are shipped to Europe and the United States.

Where imports are concerned, Argentina is the principal consuming center for sawn softwoods. At one time large quantities were received from North America, Europe and the U.S.S.R., but trade in recent years has declined in proportion to the growing importance of Paraña pine imports from Brazil. Over the past five years, economic and currency problems have produced fluctuations in the level of imports. Uruguay, on the other hand, has been able to maintain its customary flow of imports with negligible changes. Other softwood importing countries in Latin America, notably Venezuela and Peru, continue to absorb small quantities of timber from North America.

Africa

By dint of intensive afforestation with fast-growing coniferous species, Africa is steadily building up vital resources of indigenous softwood. According to FAO's *World forest inventory 1958*, Africa now possesses about 50 million cubic meters of coniferous growing stock. South Africa, which established exotic conifer plantations as early as 1918, claims 31 million cubic meters of the total, while Kenya has 11 million cubic meters and Southern Rhodesia 2.1 million cubic meters. Trade sources indicate that the current production of sawlogs in South Africa may be as high as 3.7 million cubic meters *per annum*, and FAO statistics suggest that home-grown material is now supplying about half of South Africa's total softwood requirements. Kenya, on the other hand, is largely dependent on its own sawmill capacity.

European countries provide about one fifth of South Africa's sawn softwood imports and the remainder is drawn from North America (principally Canada) and the U.S.S.R. Among the countries almost wholly dependent on imported softwood, the United Arab Republic, Algeria and Morocco are the principal markets. Over the past decade, imports of the United Arab Republic have fallen progressively and have not reached the level of 50,000 standards in any year since 1952. Supplies are obtained in the main from southeastern Europe, Sweden and the U.S.S.R. In meeting the needs of Algeria and Morocco, metropolitan France plays a leading role and as recently as 1960 succeeded in doubling her export to the latter country. Although France takes first place among Algeria's suppliers, Austria at present provides about 20 percent of the country's requirements. The bulk of Tunisia's much smaller import comes from France and Austria.

Consumption in recent years affords an imperfect guide to future needs in the African countries. Political and economic development is taking place at an accelerating pace and it seems probable that the next decade will witness a significant rise in imports and, where silvicultural conditions are favorable, a rapid enlargement of indigenous resources.

Asia

The first half of the past decade saw a remarkable upsurge in the region's sawn softwood production. China's output approximately doubled between 1950 and 1954, while Japan, the largest producer in the Far East, raised production from 2.5 million standards in 1951 to close on 4.4 million in 1957. For the region as a whole the peak year was 1957, when production attained the level of 5.4 million standards (Table 7). More recently production has been stabilized on a slightly lower plateau but still above five million standards. It is considered that the less dramatic progress noted over the past three years should be attributed in part to the growth of other branches of the forest products industry which absorb supplies of coniferous wood.

Consumption of sawn softwood in Asia is hampered by present limitations of production facilities and also by shortage of foreign exchange. These factors are especially relevant in the case of China. It has been estimated that this vast, swiftly growing economy has at its disposal about 66 percent of the growing coniferous stock in Asia; yet production, according to the figures available, is still below a million standards a year. Output potential is considerable but in the huge industrialization program now being implemented, sawmilling must take its turn. In the short term, badly needed softwood imports must be weighed in the balance with still more essential commodities, including primary foodstuffs. There is also a pressing need for manufacturing plant which will play a key part in developing China's home industries and export trade. In time, no doubt, a higher proportion of foreign credit will be available for increased timber purchases and for the logging and sawmilling equipment required to exploit untapped forest resources.

Among the countries of the eastern Mediterraneam, Israel remains the principal market for imported softwood.

A 1959 import of 57,000 standards represented the highest annual purchase to date but over a period of years the country's requirements have averaged close to 50,000 standards, so that the single year's gain holds little significance. Turkey's imports have risen and fallen year by year in the most erratic fashion and it now seems clear that increased home production is taking the place of a fairly large proportion of requirements formerly met by imported timber. Among the northern European countries, Finland has made an outstanding contribution to supplies in the Near East and since 1957 an increased volume of timber has gone into the area from the U.S.S.R. Austria, Yugoslavia, Portugal and Romania — traditional suppliers of Near East countries — have also sent in useful supplies.

Table 7. – Asia: Sawn Softwood Production and Trade
(in thousands of standards)

	1956	1957	1958	1959
Total production *	*4 850*	*5 405*	*5 125*	*5 375*
of which:				
Japan	3 933	4 403	4 169	4 411
China (Mainland) *	750	550	600	—
Turkey	97	114	106	91
Total imports *	*165*	*200*	*160*	*225*
of which:				
Israel	45	53	45	57
Turkey	10	14	3	5
Japan	18	29	18	32
Iraq	14	16	11	12
Lebanon	16	11	14	—
U.A.R. (Syria)	10	7	20	30

* Estimated.

Oceania

By 1959, production in this region, rising steadily year by year since the war, had almost reached the level of half a million standards (Table 8). New Zealand, with extensive stands of fast-growing conifers to supplement raw material supplies, has made particularly good progress. Apart from a minor setback in 1956, the upward trend in output has been continuous for some years.

After a sharp drop from the relatively high figures recorded in 1955, imports have varied little from year to year but it is anticipated that statistics for 1960 and 1961 will show a high flow of goods from Europe and Canada, as government restrictions on imports have recently undergone revision in Australia. Recent reports from the region emphasize that building activities are now assuming boom proportions. The softwood demand so created should serve as a stimulus both to domestic production and to heavier purchasing overseas.

Table 8. – Oceania: Sawn Softwood Production and Trade
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Australia	167	167	140	157
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Imports				
Australia	126	105	124	105
New Zealand	7	10	8	7
Exports				
New Zealand	18	15	20	26

Prices

After a period of relatively high and stable prices covering 1956 and the greater part of 1957, the European softwood market weakened, and throughout 1958 c.i.f. values steadily declined. The price trend was not world-wide, however, for after touching bottom in 1957, North American prices again turned upward and gathered new vitality in the spring of 1958 as orders from the United States builders poured into the mills on the Pacific seaboard. From that point onward Canadian and European prices moved farther and farther apart and for a time it became virtually impossible for merchantable Canadian timber to compete with constructional softwood produced in northern Europe and the U.S.S.R. European prices responded very slowly to the general economic recovery apparent in most parts of Europe toward the end of 1958, and the downward trend continued in some instances well into the spring of 1959. The 1958 price fall was felt keenly by the European exporters, since high log prices had been paid in the autumn of 1957 on the assumption that market conditions would be stable in the following year. In the next felling season (1958/59) producers scaled down their operations and secured their reduced log requirements at somewhat lower prices than had been paid a year earlier. Sawn softwood prices eventually became stable in April 1959 and, as consumption expanded in step with industrial recovery throughout the summer and autumn, prices gradually strengthened. By the end of the buying season, stocks in shippers' hands had dwindled to insignificant proportions and forward buying for 1960 opened exceptionally early at prices closely in line with those current at the height of the previous season's market. Some slight downward adjustment followed publication of the U.S.S.R.'s opening offer for 1960 but the upward movement was resumed when, later, the U.S.S.R. advanced its prices in an increasingly buoyant market situation.

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Table 9. - Sawn Softwood Prices

Country	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Sweden: average export price for 2 ½ in.-7 in. u/s redwood battens f.o.b. (Kr. per std.)	1959	1 135	1 130	1 145	1 145	1 150	1 155	1 155	1 160	1 185	1 195	1 200	1 205
	1960	1 215	1 240	1 250	1 255	1 260	1 265	1 255	1 260	1 260	1 260	1 265	—
United Kingdom: average price c.i.f. of imported sawn softwood (£ per std.)	1959	68.3	69.9	72.2	71.7	71.2	68.8	68.4	69.3	68.9	68.3	69.9	71.8
	1960	74.0	75.5	78.8	79.3	76.6	74.9	75.5	74.2	76.5	76.5	77.6	78.7
United States: wholesale price for Douglas Fir No. 1 common 2" × 4" (U.S.$ per 1,000 bd. ft.)	1959	79.9	82.3	84.7	86.0	87.7	89.8	89.6	89.5	88.6	87.1	82.3	82.6
	1960	83.5	83.5	83.2	83.2	82.5	80.4	80.8	80.2	80.1	79.0	78.4	—
Canada: wholesale midmonth price, Fir finish, B and better 1 in. × 6 in. (C.$ per 1,000 bd. ft.)	1959	142.4	144.2	146.7	146.7	148.4	148.4	148.4	148.4	148.4	148.4	146.7	146.7
	1960	148.4	148.4	149.2	149.2	147.4	147.4	147.4	144.0	152.8	152.8	142.1	142.1

During the whole of this period the interplay of Canadian and European offers (a major element in the shaping of international softwood prices) was lacking. In March and April, however, Canadian export prices fell sharply, owing to serious curtailment of orders from the United States and to parallel weakness in the Canadian market. Almost at once British Columbian prices reached parity with European quotations and, as northern European prices advanced still further until they approached prerecession levels, the Canadian exporters found many eager buyers in Britain and Europe. The price trends discussed above are clearly visible in Table 9.

Present indications are that sawn softwood prices will preserve a high degree of stability in 1961 but a further appreciation of values seems unlikely in view of estimates of increased availabilities and somewhat lower import requirements.

Conclusion

In the period covered by this review, most areas of the world (other than the U.S.S.R., eastern Europe and China) have experienced temporary economic difficulties followed by rapid growth and market expansion. At the time of writing, further development is in prospect and it seems probable that effective demand for sawn softwood will be commensurate with increased supplies at the disposal of the highly industrialized countries. Strenuous efforts to step up production in areas formerly dependent on imported supplies are noted with satisfaction, but it is no less clear that increased consumption in countries poorly endowed with coniferous forest and remote from the main centers of production will necessitate more rapid production and more effective distribution in the years immediately ahead.

C. G. T.

The Work of FAO

Forestry Education

A report from the FAO Advisory Panel on Forestry Education, forwarded by the chairman, Dean Hardy L. Shirley of the Syracuse University School of Forestry, summarizes the world's needs for foresters as follows.

It is estimated that today there are about 70,000 foresters, perhaps 75,000, and some 4,405 million hectares of forest land in the world. If this were to be managed at the level currently being practiced in the United States, and this level generally is still far below that of many European countries, some 300,000 foresters would be required, or about four times the number now employed. If such a goal were to be achieved by the year 1980, some 11,250 foresters beyond those required for replacement would be needed annually. The existing forestry schools of the world, including those in the U.S.S.R., are currently equipped and staffed to graduate about 8,000 men annually, of which about 3,000 are needed for replacement. The deficit between possible supply and possible need is therefore some 6,250 men.

The above estimates are crude but may be helpful in visualizing the magnitude of need on a world-wide basis.

The actual situation, however, is far more complex. Several countries are now capable of educating more foresters than their own forest services need. This is true for instance in Denmark, Switzerland, the Netherlands, Germany, and the United Kingdom. These now accept a certain number of men from outside their country. The need for new forest officers, on the other hand, is mostly in the newly developing countries of Africa, Latin America and, to a lesser extent, Asia. All countries wish to employ their own nationals as forest officers and prefer to educate them at home or in a nearby country having similar forest and economic conditions. The need, therefore, is for teachers who can help establish new schools and for means to educate increasing numbers of foresters abroad. Considerable progress is being made. Even so, some developing countries have established schools but find no jobs for their graduates in their own country, while many others need men but have no schools.

For the immediate future sufficient schools are available in North America, Europe, and in many parts of Asia. These schools can furnish qualified teachers on loan to help other countries to establish schools. Such short-term employment is not easy to arrange because of the need for continuing retirement and other benefits provided by the parent institution and because replacements, if drawn from a distance, usually require funds for moving and other costs. Sponsoring agencies as well as schools, however, should view such assignment and replacement needs as opportunities for broadening the experience of faculty members and for bringing in specialists from outside for short-term assignments. In this way instruction in several schools may benefit from foreign assignments of teachers.

The need for teachers and for forest economists who can work with planning officers is great in the developing countries and is likely to remain so for some time.

FAO Advisory Committee on Pulp and Paper

The second meeting of the FAO Advisory Committee on Pulp and Paper was held from 12 to 14 January 1961 at FAO Headquarters in Rome. R. M. Fowler, the chairman of the committee, presided and the following members and alternates participated: V. Amici (Italy), J. Frézal (France), Sir Herbert Hutchinson (United Kingdom), H. Kamel (United Arab Republic), E. Landberg (Sweden), J. P. Lévy (France), H. Niethammer (Western Germany), R. E. O'Connor (United States of America), C. Quintana (Mexico), L. Sjunnesson (Sweden), J. O. Soderhjelm (Finland).

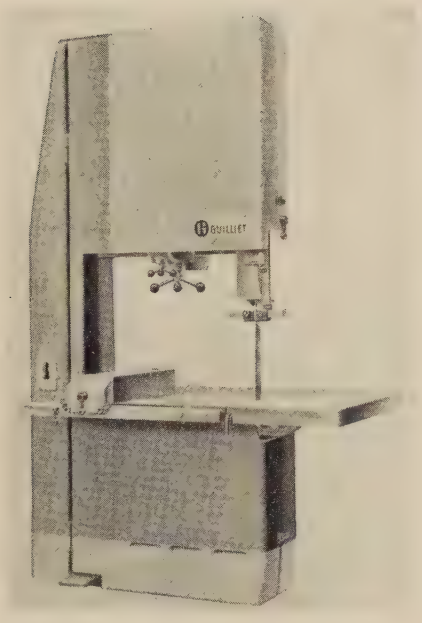
The committee heard an account of the organization and work program of the Forestry and Forest Products Division, and discussed the part played in this program by activities relating to pulp and paper, especially the steps taken or contemplated to give effect to the recommendation of the pulp and paper consultation held in Rome in 1959, subsequently endorsed by the Conference of FAO, to give greater prominence to work in this field (see *Unasylva*, Volume 14, Number 1).

Note was taken of the assistance rendered to the Government of Chile in formulating and implementing a comprehensive program of forestry and forest industry (including pulp and paper) development, and of the services provided to date to Latin-American governments by the FAO/ECLA Latin-American Advisory Group. It expressed particular satisfaction with the organization and results of the 1960 conference in Tokyo (see *Unasylva* Volume 15, Number 1) and endorsed the recommendations of that conference, laying particular emphasis on the need to revise and reissue the document, *Raw materials for more paper*. The committee noted that Asian governments would, in seeking to give effect to the Tokyo recommendations, look for increasing assistance from FAO.

From its review of the work so far carried out and the program provisionally planned for the future, the committee concluded that:

(*a*) past effort had been well deployed and had led to solid achievements of value to all member countries, including a series of publications of outstanding merit;

Equipment Section



Bandsaw Machine with Tilting Table. — The main frame is in one piece with a complete guarding of all working parts. Table can be tilted and locked in any position by means of rose handwheel. Stop provided for positive positioning of table in its horizontal position. Machine provided with pedal-operated brake which acts directly on the bottom saw pulley, ensuring progressive yet fast stopping. Machine can be connected to a dust extraction plant. Motor completely enclosed inside main frame. Saw pulley diameter 36 in. (90 cm.), table 48 × 41 in. (122 × 104 cm.). Maximum tilt of table 45°.

MANUFACTURER: *Guilliet, Rivington Street, London E.C.2.*

Tapio's Cultivator. — The cultivator prepares planting spots in two rows. It can be attached to the lifting mechanism of a wheel tractor, hydraulic pumps make it completely automatic. Two pump cylinders joined by a hose through which oil runs from one cylinder to the other and thus releases the mechanism for soil preparation in turn. These mechanisms, which consist of two pairs of pegs and two arms alternatively placed, rotate. The cultivator weighs approx. 470 kg.

MANUFACTURER: *Keskusmetsäseura Tapio, Helsinki, Finland.*

R.C.M. Clearer. — Can be used for scrub clearing and crushing. It is attached to a track-type tractor equipped with scrub-cleaning rake, bulldozer or stumper. The notched wheels chop the roots left in the ground. Stones and rocks are no obstacle as the disk rolls over those it cannot extract.

MANUFACTURER: *Rethéloise de Construction Mécaniques, Rethel, Ardennes, France.*

Fire Line Trencher. — Model K2 Rotokitten is a self-propelled fire line trencher. Specifications: Engine-gasoline 5.75 hp, independent clutching for stop and go, with or without trenching disc running. Speeds: 3 fwd, 1 rev. Trenching mechanism cuts clean 12 in. (30 cm.) fire line. Operates in rocky soil and on steep terrain. Dimensions: weight 250 lb. (113 kg.) width 32 in. (81 cm.) length 44 in. (100 cm.).

MANUFACTURER: *Merry Equipment Inc., Leavenworth, Washington, U.S.A.*

Wolseley Merry Tiller. — Machine designed for the cultivation of the soil. A range of attachments can be fitted, such as bulldozer blades, trailer seat, pump, spraying unit. By fitting the flexible shaft arrangement it can be turned into a machine which supplies power for chain saw. A saw bench for fuelwood can be used either with or without the truck. A heavy tubular front stand ensures maximum rigidity when sawing and the stand can be quickly turned out of the way for transport.

MANUFACTURER: *Wolseley Engineering Ltd., Witton, Birmingham 6, England.*

Minuteman Mobile Drill. — Drills in soil and rock, the power is transmitted from engine to drill spindles through a centrifugal clutch, a four - speed transmission and a sealed gear case.

Specifications: height 63 in. (160 cm.), width 22 in. (56 cm.), length 23 in. (5.7 cm.), weight 150 lb. (68 kg.), engine 6.5 hp. Speeds: 3 fwd., 1 rev. Drilling capacities: auger drilling diameter 3-12 in. (7.6-30 cm.), depth 50 ft. (15 m.) with 3 in. (7.5 cm.) augers.

MANUFACTURER: *Mobile Drilling Inc., Indianapolis, Indiana, U.S.A.*

Surveyscope. — Device that can measure horizontal distances by using a known or estimated vertical reference height of 6 ft. (1.8 m.). The Surveyscope permits measurement of distances up to 1,000 ft. (300 m.) at a glance. The physical aspects of the Surveyscope are as follows: 4 7/8 in. (12 cm.) long and 1 in. (2.5 cm.) in diameter.

MANUFACTURER: *Vexilar Engineering Co., Edina, Minneapolis, Minnesotta, U.S.A.*

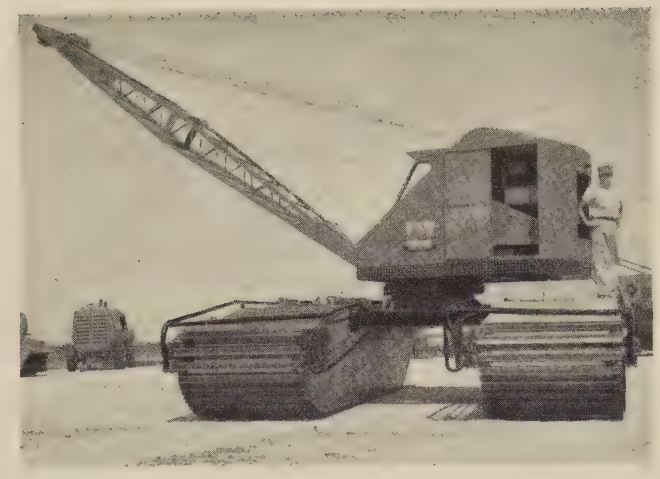
Tree Crusher. — Equipped with three electrically powered 6 ft. (1.8 m.) diameter steel rollers. Weighs 42 tons. At a speed of 3 m.p.h. (5 k.p.h.) the crusher rolls down trees at 5 acres (2 ha.) per hour. A 20 ft. (6 m.) wide push pumper applies leverage over 10 ft. (3 m.) up on the tree to break root system free of ground. As tree falls, blade studded rollers perform their work leaving a compressed mat of chopped trees and brush.

Length 39 ft. 10 in. (18.4 m.), width 20 in. (50 cm.) and height 15 in. (38 cm.). Electric power supplied by a diesel engine driven LeTourneau AC generator and LeTourneau DC generator. One single rheostat unit controls speed power and braking while a finger tip switch controls steering.

MANUFACTURER: *R. G. LeTourneau Inc., Longview, Texas, U.S.A.*

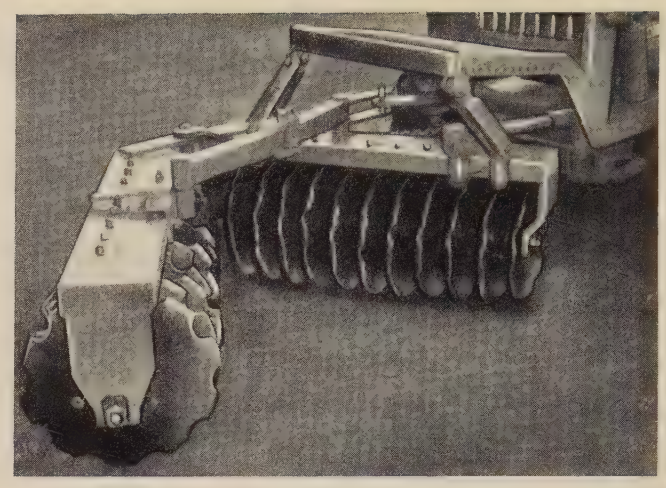
Portable Pump Filter. — Portable pump filter renders water fit for drinking. Pump housed within body of filter candle provides 15-25 gal. (68-114 l.) filtered water per hour. Sterasyl self sterilizing candles recommended so that a supply of bacteriologically safe water can be obtained without boiling candle or water. Dimensions in box: 15 × 5 × 4 in. (37.8 × 11 × 10 cm.), weight 7 lb. (3.2 kg.).

MANUFACTURER: *British Berkefeld Filters Ltd., Tonbridge, Kent, England.*



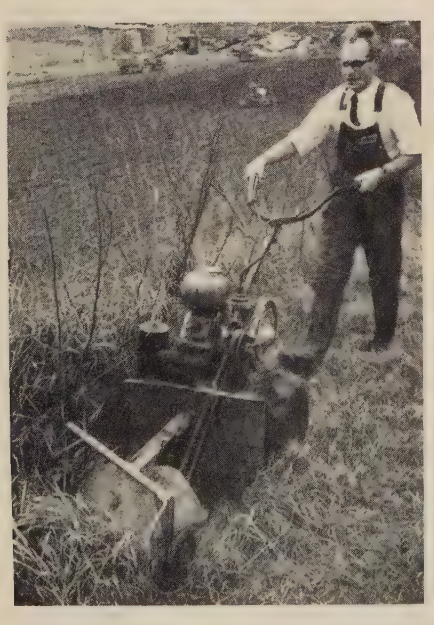
C-C Track Amphibious Dragline. — Crosses canals, creeks, streams under own power. All steel welded construction with aluminium cleated tracks. Specifications: tracks two 5 ft. (1.5 m.) wide × 23 ft. 10 in. (7.3 m.) long. Ground pressure area 17 sq. ft. (1.58 m²). Size 18 ft. (5.5 m.) wide × × 23 ft. 10 in. (7.3 m.) long. Machine can be disassembled for hauling on highway or ocean freight. Weight total 25,000 lb. (11,240 kg.). Engine Ford 4 cylinder diesel 60 hp. Transmission speeds 4 fwd., 4 rev. Speed 3-5 m.p.h. (5-8 k.p.h.). Turning radius 40-50 ft. (12-15 m.).

MANUFACTURER: *Quality Marsh Equipment Company Inc., Thibodaux, Louisiana, U.S.A.*



Motor Grader Rotary Scarifier. — The unit can scarify, pulverize, mix, aerate and still leave the front blade available for immediate use. It can be attached to any Caterpillar 12 or 14 grader equipped with hydraulic power. Two models of scarifier: 12 or 22 blades of 28 × ¼ in. (711 × 6 mm.).

MANUFACTURER: *Towner Manufacturing Co., Santa Ana., California. U.S.A.*

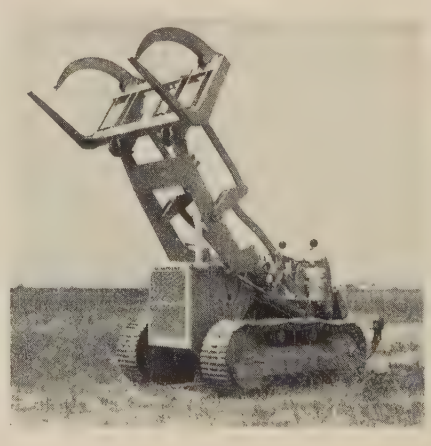


Rotary Slasher. — Rotary slasher is one of the many implements which can be mounted on the Hakorette. The machine is equipped with a 4.3 hp motor with three gears from 1 to 18 k.p.h.

MANUFACTURER: *Hako Hans Koch und Sohn, Bad Oldesloe, Western Germany.*

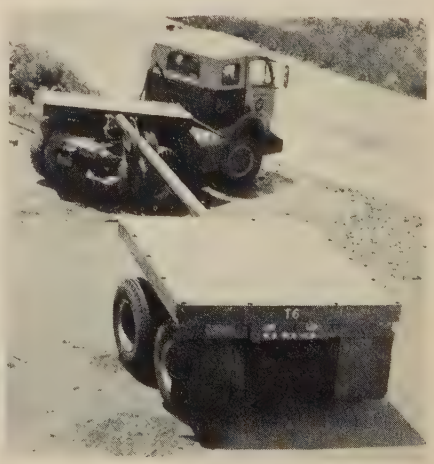
Improved Log Fork for 977 Traxcavator. — An improved log fork for the 977 Traxcavator is manufactured by Caterpillar. Two clamps have been moved inward slightly to provide a slot through which the operator can see the tip of the tine. An alternate set of top hinge points provides a choice of additional tilt to the front or rear as required. Use of the rear set of pivots provides enough tilt forward to allow the operator to pick logs selectively from a pile.

MANUFACTURER: *Caterpillar Co., Peoria, Illinois, U.S.A.*



Steer-O-Matic. — New automatic steerage axle assembly for trailer allows sharper turns, easier parking, reduces tire wear. A simple air-operated device, controlled from the truck cab, locks the unit if required. The unit is basically composed of a ball ring mount, frame, two leaf springs embedded in rubber cushions, a steering tongue, axles and wheels. Measurements of the unit are equivalent to a standard rigid unit.

MANUFACTURER: *Pollock Industries Inc., Pottstown, Pennsylvania, U.S.A.*



News of the World

Australia

• *The Natural Regeneration of Eucalyptus Regnans* (T. M. Cunningham, Bulletin No. 1, School of Forestry, University of Melbourne, 158 pp., 1960) is a comprehensive study of the problem of natural regeneration of *Eucalyptus regnans* forests after logging. The author has investigated seed production and dispersal, the fate of the dispersed seed particularly with regard to insect losses, and the factors affecting seed germination and seedling survival. He has tested methods of prelogging seedbed preparation and of partial cutting to obtain regeneration. He recommends, in addition, spraying to control seed-robbing insects, and the use of artificial regeneration methods to plant nursery-raised seedlings in those areas where natural regeneration has proved to be inadequate.

Canada

• The forestry school of Sopron, in northwest Hungary, graduated its last class at Vancouver in May, thousands of miles from its original home. The unveiling of a plaque at International House on the campus of the University of British Columbia marked the end of a dramatic story that began in November 1956. When the last sparks of the Hungarian revolt were extinguished, the entire teaching staff and student body of the forestry school, one of the best in Europe, crossed into Austria.

Early in 1957, under the sponsorship of the Canadian Government, the entire school sailed for Canada. It included 196 students, averaging 20 years in age, 12 of them girls, and 29 faculty members. There were also 21 members of the teaching staff, wives, and 50 children. In spite of language and financial difficulties, the school prospered in Vancouver.

Twenty-three students were in this year's final graduating class, bringing the total of graduates to 139. Of the 116 who had already graduated, 100 are now in forestry work, 90 of them in British Columbia. Of the teaching staff, four remain. Some of the others have transferred to other faculties, or are with other universities in North America. Some are in forest research. A few are engaged as mining or forest engineers. Of the students who dropped out of the school, eight returned to Hungary.

Cuba

• Four species of pine occur in Cuba — *Pinus caribaea* and *P. tropicalis* in the west, *P. cubensis* and *P. occidentalis* in the east, the two groups being some 1,000 kilometers apart. The species themselves tend to be isolated into monospecific stands, mostly associated with the montane zones at elevations of up to 1,000 meters of more. Both *caribaea* and *cubensis*, however, also occur down to near sea level. All four species show an unusually high proportion of straight-stemmed, light-branched trees.

Climatically, the forests enjoy good rainfall, 1,450 to 2,000 millimeters, well distributed, with one rainy season May to November. Relative humidity averages 75 percent, temperatures are tropical. Soils vary considerably, in both origin and character, from the ferruginous clays of the Sierra de Nipe to the shallow sandy loams over phyllite in the west.

Most of the pine forests have been heavily exploited in the past but more recently they have been brought firmly under protective control, including the prohibition of burning, and a start has been made on reforestation. The forest department is at present using mainly *P. caribaea* in the form of polythene-potted nursery stock for its planting programs. This work is being aided by the creation of national parks in certain of the more accessible and picturesque forest zones.

Fiji

• The United Kingdom has made a grant totaling U. S. $ 29,300 for a research project designed to help Fiji's timber resources. Fiji has a wide range of timbers, but more scientific and technical knowledge is needed about their properties in order that they may be developed to the best advantage.

A timber research unit will be set up in the colony to carry out investigations and make tests locally. In addition it will prepare samples of different species of timber to send to the Commonwealth Scientific and Industrial Research Organization in Melbourne for more detailed scientific examination.

Gambia

• An interesting development in 1960 was the introduction of a slightly modified taungya intercropping trial in N'Yambai forest park, which gave extremely satisfactory results. The crops employed were groundnuts and upland rice.

Initially, public response was poor to the invitation to farm between the newly planted trees — a basic 7 × 7 feet (2 × 2 meters) admixture of *Gmelina arborea*, *Albizzia lebbek* and *Khaya senegalensis* introduced species for field trials at very wide espacement in rows 49 feet (15 meters) apart. It was believed that damage by monkeys and other wildlife within the forest park would preclude attempts to grow crops.

Fortunately, however, enough interested farmers were eventually forthcoming to enable 25 acres (10 hectares) of intercropping with groundnuts and the equivalent area with upland rice. Despite the late sowing a better than average harvest was enjoyed from both crops.

Japan

• A nation-wide forest tree breeding project started after the last war. Before that time, some interested foresters had undertaken a limited amount of work on selection of elite breeding stock for various species, and research had been developed in the forest experiment stations and universities.

In 1952 a Forest Tree Breeding Association was established and in the same year, Professor Bertil Lindquist of Sweden visited Japan in order to promote interest in forest tree breeding. Since 1954, the selec-

tion of elite trees has spread in the national forests and in some prefectures, and at the same time tree breeding research institutes have been established by private organizations. From 1957, government subsidies have enabled all prefectures to proceed with the selection of elite trees, and as a result, nearly 6,000 elite or plus trees have been identified.

Nine government tree breeding stations have now been established, distributed over the country according to the site, climatic and other conditions. Their task is to carry out progeny tests and to produce new superior species through the media of mother material of elite trees of both indigenous and exotic species. Seed or tree orchards for the propagation of superior seeds and seedlings are established in each forest region and district in all prefectures, to supply better seed and planting stock for the national forests, to dealers in seed and plants, and to forest owners' associations.

Jordan

• The northern forest zone in Jordan is both actually and potentially the forest area of greatest productivity, and lies nearest the main centers of population. The forests lying in the south of Jordan, which are more heavily exploited and will require a rather long period to rehabilitate, are furthest from the main population concentrations.

The northern forests lie on the hills to the east of the River Jordan and comprise the whole of the pine forests of the country together with associated areas of mixed hardwood forest (mainly oak) and areas of forest scrub and *maquis*. The area covered by these forests is estimated at 134,000 hectares, which represents about one quarter of the land classified as forest tree-bearing, but these figures are only rough estimates pending the forest inventory which will give precise figures for the land under various tree crops.

The forests have been overexploited, overgrazed and are in general in very poor condition. Much of the earlier exploitation occurred at the time when the forests provided the fuelwood for the Hejaz railway. Since the end of the first world war the forests have not been exploited for this purpose, but they have nevertheless been seriously overcut by the local population for fuelwood and poles. Moreover, the forests have not been allowed to regenerate properly, since the tribesmen living in the area maintain large flocks of goats.

Within relatively recent times the Government of Jordan has taken steps to conserve the remaining forest land. Illicit cuttings have now been brought under control and grazing has been excluded from the main pine forests. The consequent recovery of these forests, with good natural regeneration, has been quite remarkable.

The Forest Department is also responsible for range management and, in view of the serious livestock problem, a dual forestry/range management approach to the vegetation conservation problems of the country has been developed.

Local fellings in the forests amount to approximately 90,000 cubic meters annually, of which a mere 3,700 cubic meters consist of industrial wood, the remainder being fuelwood and wood for charcoal. The supply of the latter is sufficient to meet local demand, but the bulk of the industrial wood consumed still has to be imported. Imports of industrial wood have been steadily increasing, and today amount annually to about 100,000 cubic meters of roundwood, representing a value of more than U.S. $ 4 million. However, even with this heavy burden of imports the country's wood consumption amounts to only 55 cubic meters per 1,000 inhabitants, which is only half of the average of the Near East and one tenth of the world average. With a population increase of 1.6 percent in the past, but expected to increase to 3 percent, and the Government's decided policy to raise standards of living, consumption of wood will increase substantially. Since a concomitant increase in imports is excluded, the Government has no alternative but to develop the indigenous forest resources in order to cope with future requirements. It has decided to face this challenge.

Libya

• The Jebel Akhdar area of northern Cyrenaica supports the best forest stands in Libya, and has the highest rainfall in the country. The main forest area forms the highest plateau in Cyrenaica, having a mean elevation of 600 meters above sea level and is almost entirely timber land.

The dominant feature of the central sector of this area is a cypress forest peculiar to subhumid zones (rainfall 450 to 650 millimeters). Associated with cypress (*Cupressus sempervirens*) in great abundance are oak (*Quercus coccifera*) and juniper (*Juniperus phoenicea*), together with olive (*Olea oleaster*), *Pistacia lentiscus* and carob (*Ceratonia siliqua*). The total area of forest is about 60,000 hectares and the trees vary from 20 to 25 meters in height. This central sector is surrounded by about 100,000 hectares of more open juniper woodland associated with *Pistacia*, olive and *Arbutus*. In a few places this woodland can be regarded as true forest, in others it is better termed *maquis*.

On a lower plateau lying to the north and east of the former, is another area of forest with the rainfall varying from 300 to 550 millimeters. It is estimated that within this area are some 10,000 hectares of closed forest and about 130,000 hectares of more open woodland. Tree species occurring in this area include juniper, oak, cypress and a certain amount of pine (*Pinus halepensis*).

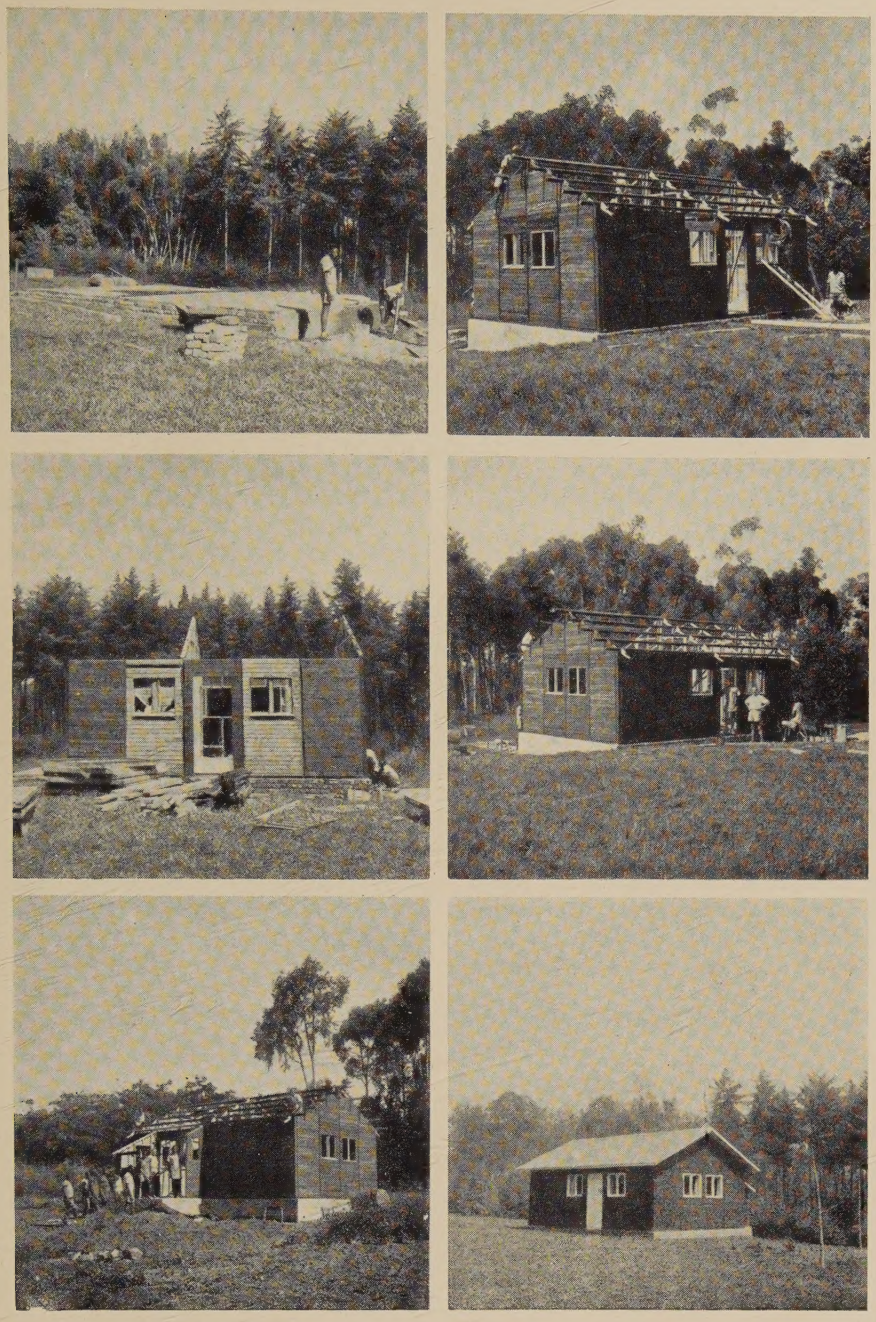
Some agricultural settlements remain from the 1930's, but planned development of the region since the end of the second world war has been hampered by the lack of knowledge of the natural resources of the area. With the recent successful search for oil in Libya, it is anticipated that the revenue of the country will be substantially increased from 1963 onward. The Libyan Government has formed a development council to administer the bulk (70 percent) of the oil revenues and plans to use this money for permanent development projects. Since the inhabitants are mainly pastoral, the part to be played by agriculture in the future development of the country will be considerable.

Mauritius

• Very severe damage was caused to the island by the two cyclones "Alix" (19 January 1960) and "Carol" (28 February 1960).

The damage caused by "Alix," the milder of the two cyclones, was restricted mainly to *Eucalyptus* plantations, particularly in the upland regions, while coniferous crops and plantations of other species suffered remarkably little damage.

The rehabilitation of *Eucalyptus* plantations has gone hand-in-hand with the exploitation of poles for the reconstruction of houses blown



RUANDA URUNDI. – *Construction of the prefabricated wooden house: from Figure 1, eight hours after start of work, to Figure 6, the house completed after 16 hours.*

Courtesy, Figures 1 to 5, R. Wathelet
Figure 6, M. Reynders

down, and at the close of December 1960 approximately 900,000 poles had been cut and distributed or sold.

The second cyclone " Carol " passed directly over the island from north to south and was the most intense ever recorded in these regions. It was accompanied by winds of a maximum velocity exceeding 175 m.p.h. (280 km/h) and spared little. Owing to delayed action deaths in tree crops, it has not yet been possible finally to assess total damage in plantations, but approximately 2,000 acres (800 hectares) of pine plantations of 12 years of age and over were virtually destroyed, leaving an estimated 1,500,000 cubic feet (42,000 cubic meters) of timber to be harvested without delay. An unusual feature of the damage was that the vast majority of the older pine trees were broken at varying heights from the ground, few having been blown down. In past cyclones the number of blown down trees exceeded by far those which were broken by the force of the winds.

Damage to the indigenous forests was unusually severe in many places, where large numbers of the older and mature trees were blown down or broken at varying heights from the ground, leaving gaps in a canopy which was previously closed. Delayed action deaths were also becoming increasingly apparent some ten months after the cyclones. Severe damage in the indigenous forests has been unknown in the past.

The coastal *Casuarina* plantations, which suffered little from " Alix," were destroyed by " Carol." Initial assessments of damage appeared to indicate that damage, though severe, was not crippling, but the accumulating effects of delayed action deaths have made it apparent that approximately 80 percent of the *Casuarina* plantations have been irretrievably damaged and will have to be replanted.

The failure of large numbers of timber buildings to withstand the effects of the two cyclones has created a lively interest in the value of timber preservatives. A number of local timber merchants have shown quickened interest in the use of preservatives and this will, it is hoped, lead eventually to the increased utilization of softwoods.

Ruanda Urundi

• There is much prejudice against wooden houses in Central Africa although they are common in Southeast Asia where climatic conditions are similar. Efforts are increasing to make wooden houses more popular, in the Central African Republic for instance and in Ruanda Urundi.

The photographs show a simple prefabricated house produced at the *Institut national pour l'étude agronomique du Congo* (INEAC) research station in the latter territory. The idea was to produce a strong, comfortable, transportable dwelling, simple in design and assembly, and cheap.

From the construction of the subfoundation (Figure 1), a cement slab 20 centimeters above ground level to obviate the danger of rot or decay and termites, to the erected building (Figure 6) took about 16 hours. The basic wall element is a panel 1.20 × 2.40 meters. The timber used was *Cupressus lusitanica* obtained by thinning a 23-year old plantation. The wood was ripsawn into boards and then rough-planed.

Tristan da Cunha

• An interesting official report on this remote island in the South Atlantic ocean describes the natural vegetation of the lower slopes as a thicket of *Phylica arborea* (a contorted semiprostrate tree reaching 15 feet) and tree fern (*Blechnum palmiforme*). *P. arborea*, the sole source of firewood, has been heavily overcut. Constructional timber is completely lacking. Planting trials were begun in 1954 with trees including *Eucalyptus viminalis*, *E. ficifolia*, *Acacia decurrens* var. *mollissima*, *Pinus pinaster*, *P. radiata*, *P. halepensis*, *Pittosporum crassifolium*, *P. undulatum*, *Salix* and *Populus* spp., and *Cupressus macrocarpa*. It appears that *P. pinaster* and *P. radiata* are most resistant to the salt-laden wind, and these, with *E. viminalis* in sheltered places, form the bulk of current planting (1,500 trees planted in 1959). The first 50 eucalypts are ready for cutting.

United Kingdom

• The program of instructional courses arranged by the Timber Development Association (T.D.A.) in 1960, comprised a total of 18 different courses of the following categories:

2 week-end residential courses for practicing engineers and architects;

1 timber engineering course addressed to T.D.A. instructors in timber technology;

1 course in timber technology to meet the requirements of T.D.A. instructors from Northern Ireland and others;

3 plywood salesmens' courses;

3 softwood salesmens' courses;

3 hardwood salesmens' courses;

1 course on " timber and its uses " to meet requirements of Royal Navy personnel interested in the subject;

2 courses on structural glue laminated construction for approved manufacturers;

3 courses on the construction of connectored timber assemblies for approved manufacturers.

United States of America

• *Financial management of large forest ownerships* (Yale University School of Forestry, Bulletin 66, New Haven, 124 p., 1960, $ 2) is a significant step toward the needed integration of forest management and corporation management. It consists of seven papers presented at the 13th Industrial Forestry Seminar held by the Yale University School of Forestry. The seminar papers were confined to a treatment of large forest ownerships in the United States and since conditions for investment and corporate management differ widely, direct applicability to other areas will be difficult. Nevertheless, many of the points discussed will hold wide interest.

• The Smithsonian Institution is reprinting Paul C. Standley's *Trees and shrubs of Mexico*, Contr. U.S. National Herbarium, Vol. 23, 1920-26, Parts 1 (xviii + 1-169), 2 (xxxvii + 171-515), 3 (xxviii + 517-848), and 5 (ii + 1313-1721), in 2 paper-bound volumes, pts. 1-3 and pt. 5, respectively. The price of these four parts is $ 20, postpaid. Part 4 (xxxix + 849-1312), which is available in the original 1924 edition published by the U.S. National Museum, will be enclosed free of charge. Orders should be accompanied by check and should be addressed to: Publications Distribution Section, Smithsonian Institution, Washington 25, D.C.

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